Riparian Forests of the Wild and Scenic Missouri River: Ecology and Management

Prepared for:

Lewistown Field Office, Bureau of Land Management
Lewistown, Montana

By:

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Executive Summary

Riparian forests, comprised mostly of plains cottonwood, are the most important terrestrial habitat within the Upper Missouri Wild and Scenic River corridor. Forested riparian areas provide essential habitat for numerous wildlife species, ranging from birds and small mammals to amphibians and invertebrates. Unfortunately, most of these areas are seriously degraded by human-related disturbances and the encroachment of non-native plants. However, the Wild and Scenic portion of the Upper Missouri, although affected by upstream dams, still retains a semi-natural flow regime. Thus, unlike most other large western rivers, the Upper Missouri probably still possesses the natural hydrological processes necessary for successful cottonwood regeneration (Scott et al. 1997).

This study focuses on the critical habitat components of riparian forests in the river corridor and the environmental and cultural factors that influence them. Vegetation composition and woody structural complexity were examined at 154 plots in relation to nonnative plant infestation, livestock impacts, natural disturbance, soil factors, terrace height, and mapped riparian forest types (Hansen 1989). We also surveyed opportunistically for amphibians, reptiles, bats, mussels and rare plants in the river corridor.

Our surveys documented two amphibian species, five reptile species, five bat species, three mussel species and five small mammal species. Four of these species (northern leopard frog, spiny softshell turtle, Townsend's big-eared bat, and black-tailed prairie dog), are considered Montana Animal Species of Concern. Those four and the long-eared myotis are also designated BLM Sensitive.

Nonnative plants, including five species of noxious weeds, strongly dominate the herbaceous layer of most stands. Our analysis found that increased cover of exotic species was correlated with reduced species richness in both the herbaceous and shrub layers. Smooth brome was the most common and abundant species in the herbaceous layer of most stands. This exotic species, although not considered noxious, can significantly reduce species diversity and alter stand dynamics by limiting woody species regeneration. Current vegetation patterns are dominated by the overwhelming influence of nonnative species and past disturbances.

A browse evaluation indicated that more palatable shrub species have been heavily browsed and some, like red-osier dogwood, have been virtually eliminated. The remaining shrub layer in most stands consists of species like rose and snowberry that reflect the most extreme disturbance state short of complete shrub elimination (Hansen 1989).

Stands were ranked based on three indices: species richness/exotic herb cover, structural diversity, and these two combined. Highly ranked stands will have greater potential for conservation and restoration.

Most of the eastern half of the riparian corridor is free from Russian olive, a woody invasive with the capacity to fundamentally alter the ecosystem function and composition of riparian areas, with considerable negative impact on habitats for many species of birds and probably also bats. The heavy-seeded Russian olive is most likely to invade where there are nearby domestic plantings (Lesica and Miles 1999). Given the isolation of this eastern half and the dominant public ownership, it may be possible to control Russian olive in this stretch. The semi-natural hydrology and absence of Russian olive offer an important but time-limited opportunity to maintain relatively natural cottonwood stands along a large western river, with considerable habitat and human aesthetic benefits. The invasive tree tamarisk occurs downstream and also has major ecological effects in riparian areas. Keeping these invasive species out will require monitoring and quick control.

Much of the high habitat value of riparian forests to birds and bats depends on the composition and structure of the vegetation. We

netted a predominance of female bats indicating preferential use of riparian forests as maternal sites. The decline in woody structural diversity, shrub composition, and native species cover must be reversed for these riparian forests to continue supporting certain groups of birds and bats. Insectivores and cavity users, including some Species of Concern, will likely be especially affected if Russian olive or tamarisk are allowed to infest this area.

While there has been some research on the negative impacts of Russian olive to many species of birds, little has focused on Montana and there has been virtually no research on how other vulnerable wildlife species are likely to be impacted, particularly bats and small mammals. Such research is needed to identify vulnerable species and assess the threat to their long-term sustainability.

While many forested riparian stands along the Wild and Scenic Missouri River corridor are seriously degraded by past human disturbances and nonnative plant invasion, there are still some stands that have considerable native vegetation cover and good structural diversity. The relatively natural hydrology and lack of Russian olive infestation create a unique opportunity to retain many characteristics and values of these important prairie forests. A further opportunity will occur after the next flood large enough to regenerate cottonwood stands. These new stands could be managed for native plants and natural structural diversity. Even though this stretch of the river retains some natural large floods, the size and frequency has diminished and continued coordination among agencies may be necessary to maintain this critical factor in the future.

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Elizabeth Crowe led the project with skill and enthusiasm through most of the preparatory and data collecting phases. Steve Cooper's expertise in the vegetation field sampling and report generation was invaluable. Coburn Currier, Paul Hendricks and Susan Lenard skillfully collected the zoological data; Paul Hendricks also assisted in summarizing zoological data and writing the report. Thanks to Sue Crispin and Marc Jones for editing help, Coburn Currier for layout and production, Kathy Martin for reference assistance, Karen Walker and Allan Cox for map expertise, and to others at the Montana Natural Heritage Program who helped in a variety of ways.

Though this report has profited from the support and contributions of many people, any errors rest with the primary author, Greg Kudray.

Table of Contents

List of Figures

List of Tables

LIST OF APPENDICES

INTRODUCTION

Purpose and Objectives

Other than the river itself, riparian forests probably represent the most important resource within the Missouri National Wild and Scenic River corridor. These forests, which are primarily dominated by stands of plains cottonwood (*Populus deltoides*), offer virtually the only forest environment in the prairie landscape and provide the richest wildlife habitat in the region (Finch and Ruggiero 1993). Recreation values are also high; virtually all camping areas along the river are located under the shade of these trees.

However, western riparian cottonwood forests have declined sharply over the last century (Rood and Mahoney 1990). Existing stands are often degraded by alteration of natural disturbance regimes in the floodplain, improper grazing, and nonnative plant invasion. Regeneration of new stands has been substantially limited in many areas because reservoirs have altered the dynamic flood regime critical to stand establishment.

The riparian cottonwood stands of the Missouri National Wild and Scenic River are an essential part of this special ecosystem. However, information was lacking on the condition of these communities as well as the factors that are degrading their habitat and aesthetic values. This study documents key vegetation components including species richness, structural diversity, community composition, and exotic plant invasion. Environmental factors including grazing, disturbance, soil texture, and terrace height are also related to vegetation characteristics. Preliminary surveys were also conducted for selected animal groups along the river corridor, particularly bats and other small mammals associated with cottonwood stands; all amphibian and reptile observations were documented, with special emphasis placed on turtles. Information about bat and turtle occurrences along prairie river corridors in Montana is quite limited.

The goals of this study are:
1) evaluate the critical habitat components of riparian forests in the river corridor and the environmental and cultural factors that influence them; and
2) better understand the distribution of bats, small mammals, mussels, reptiles and amphibians along the riparian corridor.

Riparian Habitat Overview

Natural riparian corridors are the most diverse, dynamic, and complex terrestrial habitats in the world (Naiman *et al.* 1993). They form an interface between aquatic and upland systems with sharp environmental gradients that structure an unusually diverse mosaic of landforms and vegetation communities (Naiman *et al.* 1993). The presence of water, diverse vegetation communities, and woody plant structure is especially important in the plains of the arid West. A review of riparian habitats by Finch and Ruggiero (1993) lists many unique values of riparian habitats. In the West, they form the sole habitat for many species of small mammals, bats, songbirds, amphibians, and reptiles, including some rare and declining species. Riparian ecosystems are also essential in maintaining the biological diversity of the surrounding uplands (Naiman *et al.* 1993). A high percentage of the animal species in arid regions need riparian habitats for part of their life cycle (Brinson *et al.* 1981).

While comprising less than 1% of the western landscape, riparian areas provide habitat for more species of breeding birds than surrounding uplands (Knopf *et al.* 1988). Riparian areas are even more important to migrating birds, sheltering more than 10 times as many species as the surrounding uplands during the spring migration (Stevens *et al.* 1977) and 14 times as many during the fall (Hehnke 1979). The highest densities of nesting breeding birds in North America have been reported in cottonwood riparian forests (Johnson *et al.* 1977).

The proportion of vertebrates found in Great Plains riparian areas is also greater than in other habitats (Brinson *et al.* 1981). In addition, riparian forests may be important dispersal corridors for flightless vertebrates (Friedman *et al.* 1997) and may comprise the only suitable regional habitat for some amphibians and invertebrates (Patten 1998). Three amphibian species, two reptile species, and eight bird species on the Montana Animal Species of Concern list are closely associated with riparian habitats in prairie regions. At least three additional reptile species, eleven bird species and ten mammal species on the Species of Concern list regularly use riparian cottonwood habitats.

Cottonwood Riparian Forests

Cottonwoods have been recognized as a keystone species in riparian ecosystems (Patten 1998) – i.e., disproportionately important to the overall community. Loss of riparian cottonwoods is often not offset by enrichment from other tree species, and when these cottonwoods die so does the riparian forest ecosystem (Braatne *et al.* 1996). The loss of riparian cottonwood forests has been especially acute in the southwestern U.S., but similar declines have been recognized in the northern U.S. including Montana (Braatne *et al.* 1996). The causes of decline vary with specific area, but a summary by Braatne *et al.* (1996) ranks improper livestock grazing, water diversion, domestic settlement, exotic plants, and reservoirs as the top five contributors.

The small, light seeds of cottonwoods only regenerate on newly exposed, moist sand or silt (Rood and Mahoney 1990). In a detailed study of cottonwood establishment along the Missouri National Wild and Scenic River corridor, Scott *et al.* (1997) found that cottonwood establishment and survival along this stretch of the river depend on floods with a flow greater than 1400 m^3/s (measured at Fort Benton). These floods create suitable seedbeds that are high enough above the channel bed to minimize flow- or ice-related disturbance that would eliminate reproduction (Scott *et al.* 1997). Since this stretch of the river is considerably downstream from any reservoir, they believe it to be the least hydrologically altered portion of the alluvial Missouri River. Their analysis concluded that the current lack of younger trees documented by Hansen (1989) is not due, as Hansen suggested, to the presence of upstream dams, but to the highly episodic nature of floods that are 1400 m^3/s or greater, which have an average

Figure 1. Cottonwood stand on the Wild and Scenic Missouri River.

recurrence interval of 9.3 years (Bovee and Scott 2002).

If Scott *et al.* (1997) are correct, then this river stretch is relatively rare among most large western rivers in still possessing the hydrologic regime necessary for cottonwood establishment and survival. Since many other riparian species also require hydrologic conditions similar to those necessary for cottonwood regeneration (Patten 1998), the current hydrologic regime (if it continues) may be sufficient to provide the essential ecological foundation for healthy riparian forests along this corridor into the future. However, while a natural flood regime is critical, it does not guarantee healthy riparian habitats. Other disruptions to cottonwood forests can significantly degrade or eliminate their habitat values.

Nonnative plants present the most serious and immediate threat to this ecosystem. There are several reasons why weeds are particularly successful in riparian environments. Regular flood disturbances create suitable environments for seedling establishment, and the river provides a dispersal vector through a continuous corridor of suitable habitat. Nonnative plants in riparian areas can virtually eliminate native herbaceous vegetation, significantly altering the composition and structure of the ecosystem. This results in lower species diversity and degraded habitat. One invader, Russian olive (*Elaeagnus angustifolia*), may also fundamentally alter the successional dynamics of riparian forests because it can reproduce under shade and create self-replacing stands (Katz and Shafroth 2003) that no longer provide habitat for some species of birds and bats.

Improper grazing has been considered the most important negative impact to riparian cottonwood forests across all of western North America (Braatne *et al.* 1996). It is also of specific concern on the Missouri River (Behan 1981). Cattle exhibit a strong riparian area preference for a variety of reasons including forage palatability (related to moisture content), availability of water, shade in hot weather and shelter in cold weather (Ames 1977). Cattle graze and trample seedlings, which can result in stand disintegration as older trees die and are not replaced (Braatne *et al.* 1996). Improper livestock use in riparian areas has been associated with increased erosion, reduced plant vigor, and altered vegetation age structure and species composition (Knopf and Cannon 1981, Kauffman and Krueger 1984, Skovlin 1984). Fortunately, if grazing regimes are corrected, riparian areas generally improve quickly (Rickard and Cushing 1982, Skovlin 1984), although vegetation responds more slowly than fish communities. (Knopf and Cannon 1981).

Study Area Description

Land Use and Ownership

The Missouri River originates in southwestern Montana where the Jefferson, Madison, and Gallatin Rivers join near the town of Three Forks. The river flows freely to the north for only about 15 miles until it reaches Toston Reservoir. The backwaters of Canyon Ferry Reservoir begin about 15 miles downriver from Toston Dam. Hauser and Holter dams are immediately downstream from Canyon Ferry, and below them, the river is free flowing until the Great Falls area, where there are several small dams. Below Great Falls, the stretch from Fort Benton to Fred Robinson Bridge was designated as a National Wild and Scenic River in 1976 and is free flowing, with many small and several medium-sized tributaries. Much of the surrounding land in this stretch was designated a National Monument in 1999. Modified hydrology due to the backwaters of Fort Peck Reservoir begins near the end of the Wild and Scenic reach.

Ownership along the corridor is mixed. The upstream half of the 149-mile Wild & Scenic River stretch is mostly private, while the lower portion is largely public land managed by the Bureau of Land Management (BLM). The last ten miles of this section is within the Charles M. Russell National Wildlife Refuge (CMR), managed by the U.S. Fish and Wildlife Service. The BLM manages the land along the river primarily for livestock grazing and recreation. Livestock grazing has not occurred on CMR riparian forests within this area for at least 20 years (Jones pers. comm). Scott *et al.* (1997) reviewed the condition of cottonwood stands along the river and their past use by native Americans, settlers, and steamboat fuel harvesters, concluding that cottonwoods now occur in small, scattered stands similar to those described in 1805 by the Lewis and Clark expedition.

Geology, Landforms, and Soils

About the first 25 river miles of the western reach of the Wild and Scenic Missouri flows through an area of Pleistocene glacial deposits underlain by the Marias River Formation (Berg and Vuke 2002). There are some minor outcrops of dark gray shale (Kevin Member) along the river corridor (Berg and Vuke 2002). The floodplain is generally about 1/2 mile wide in this far western stretch.

Glacial deposits disappear as the river flows easterly, and bedrock formations of the Eagle Sandstone and Telegraph Creek Formations dominate with Claggett Shale farther from the river (Wilde and Porter 2001, Lopez 2002). The river flows through a constrained floodplain that is about 0.25 miles or less in width until reaching the Judith River confluence, where there are several square miles of alluvial deposits in a floodplain that is 2 miles wide (Wilde and Porter 2001). The dominant bedrock in this area is variable but generally transitions to Claggett Shale along the river with the Judith River Formation nearby. Bearpaw Shale is typically higher on the landscape (Wilde and Porter 2001). The alluvial floodplain widens from about 1/3 mile to a mile or more along the last 10 miles of the Wild and Scenic River (Wilde and Porter 2001). In that reach, bedrock outcrops of Claggett Shale give way to the Judith River Formation and Bearpaw Shale (Wilde and Porter 2001).

All of the sampled plots along the river are located on the alluvium of modern channels and floodplains composed of sand, silt, and clay deposits (Porter and Wilde 2001, Wilde and Porter 2001, Lopez 2002, Berg and Vuke 2002). Some are close enough to adjacent slopes to be impacted by erosional deposition. Vegetation is particularly affected by saline or alkaline bedrock sediments (Hansen 1989).

Climate

The climate of this part of Montana is generally cool and dry, although summers and winters exhibit considerable extremes in temperature. The following is summarized from the Western Regional Climate Center (Western Regional Climate Center 2004). A weather station near the center of the Wild and Scenic River Corridor at Iliad, MT, reports that January is the coldest month of the year with an average low of 6.3°F and an average high of

30.0°F. July is slightly warmer than August with an average low of 51.9°F and an average high of 85.6°F. Most of the precipitation falls in the late spring and early summer. June averages 2.32 inches of rain while February has only 0.39 inches of snow or rain. The average annual precipitation is 12.81 inches.

Wind speeds measured at the Havre and Lewistown airports indicate an average of around 10mph, with the highest winds reported in the spring and December. An easterly or southeasterly wind direction is common in the summer with generally southwesterly winds in the winter and more westerly winds in spring and fall. Tornados are rare, but hailstorms and thunderstorms are relatively common with high winds that can break off limbs or blow down trees along the river corridor. These winds can have a significant disturbance impact on cottonwood stands, particularly as the trees age and become decadent.

METHODS

Overview

Field sampling was conducted during July and August of 2003 and 2004. One hundred fifty-four cottonwood stands were sampled: 126 in 2003 and 28 in 2004. All sample plots were taken on public land. Zoological data was collected opportunistically, either while crews progressed downriver, or at campsites selected with a mature cottonwood canopy suitable for netting bats. The majority of the animal inventory occurred in the stretch of river between Coal Banks and Judith landings. Joe Frazier, Hydrologist from the Lewistown BLM Field Office, selected the 2003 vegetation sampling locations. These stands were chosen from riparian mapping of the corridor conducted by Hansen (1989), and focused on green ash stands and mature cottonwood stands. A description of data collected is summarized in Table 1.

The 2004 plot locations were limited to the stretch of river from Judith Landing to James Kipp State Park. Based on preliminary results from the 2003 plots, the 2004 plots were focused on locations that were clearly isolated from grazing, such as islands surrounded by deep water, and on comparable nearby mainland stands. Additional environmental data was also collected in 2004. A few stands were sampled in both 2003 and 2004.

GPS locations were recorded for plot centers in 2004. Plots sampled in 2003 were reference by

Table 1. Data collected or calculated, data was recorded for both 2003 and 2004 plots unless noted.

Plot GPS location
Riparian mapping polygon number and type (Hansen 1989)
Canopy cover % class for graminoid species
Canopy cover % class for fern and fern allies species
Canopy cover % class for forb species
Canopy cover % class by species in low shrubs (<.5m tall)
Canopy cover % class by species in medium shrubs (>.5m and <2m tall)
Canopy cover % class by species in tall shrubs (>2m tall)
Canopy cover % class by species in large trees (>9” dbh)
Canopy cover % class by species in pole trees (<5” and <9” dbh)
Canopy cover % class by species in small trees (<1” and <5” dbh)
Canopy cover % class by species in sapling trees (<1” dbh)
Number of woody structural layers with >1% cover
Total woody cover
Number of woody native and nonnative species
Number of herbaceous native and nonnative species
Total number of native and nonnative species
Relative cover of nonnative herbaceous species (0 = none, 1 = 100%)
Exotic/species richness index
Structural diversity index
Description of community and immediate area
Percentage of exposed bare soil attributed to human causes (2003 only)
Percentage of exposed bare soil attributed to natural causes (2003 only)
Browse growth form class by shrub species (2003 only)
Plot height above river level (2004 only)
Soil texture description to 3m (2004 only)
Miscellaneous secondary environmental data (2004 only)
Zoological data collected opportunistically (not plot based)

centroid coordinates from chosen polygons. A representative location was chosen within the polygon for sampling. All plots were coded with the riparian mapping polygon number and associated mapping type from Hansen (1989), and mapping types found to be inaccurate were corrected. Photos were taken at each plot location, and a general description was recorded, including miscellaneous comments and animal observations. The 2004 data included both a general description and a community description that detailed specific aspects of the vegetation community and the soil profile.

Vegetation Data

Vegetation sampling was generally similar in both years; additional data were collected on browse condition during 2003. Vegetation data was collected from a 400-m^2 circular plot chosen to be representative of stand conditions. Each species present within each life form and structural category (Table 1) was assigned a canopy cover value based on a 10-class system. All areas surveyed were also searched for Plant Species of Concern.

Disturbance and Environmental Data

Two categories for coverage of bare soil were coded for each 2003 plot: (1) the amount of bare soil attributed to human-caused activities including grazing, roads, or camping activities, and (2) the amount attributed to natural causes, such as flood sedimentation or wildlife use. Some tree decadence data was also collected in the 2003 plots. The 2003 data were recorded using a rapid ecological assessment form to maximize the number of stands sampled; no measurements of environmental variables were taken. Standard Montana Natural Heritage Program community survey forms were used to document plots in 2004 and included precise GPS location and elevation data in addition to ground cover in various classes, microtopography, landform, topographic position, and soil data.

Species of shrubs and small trees at each 2003 plot were coded for browse evaluation (Keigley and Frisina 1998) in maturity classes of older, mature, or young. Classes were (1) uninterrupted (produced by light-to-moderate browsing), (2) arrested (produced by intense browsing), (3) retrogressed (produced by a change from light-to-moderate browsing to intense browsing), and (4) released (produced by a change from intense browsing to light-to-moderate browsing (Keigley and Frisina 1998). All maturity classes were combined for individual species that occurred in more than five plots, and a percentage breakdown into browse categories was calculated. A similar summary was conducted for all species within maturity and browse classes.

At each 2004 plot a soil auger was used to sample the soil to 3 meters or the apparent water table unless prevented by obstructions such as large gravel or rock. The texture and depth of horizons or layers in the soil were noted. This soil information was later summarized into one of five soil textural classes (Appendix C - Table 1) that was dominant within several depth classes (0-50cm, 0-100cm, 0-200cm, 0-300cm, 50-100cm, 100-200cm, and 200-300cm). The 2004 plots were also coded for grazing accessibility; plots were considered accessible unless they were on island locations surrounded by deep water. A height pole with a clinometer was used to determine plot ground height above river water level.

Animal Data

Animal survey work was concentrated between Coal Banks Landing and Judith Landing, although some observations were made during 2003 between Judith Landing and Fred Robinson Bridge. Animal observation points (Appendix D - D-5 and D-6) correspond to plot maps (Appendix D - D-1 through D-4). Observation points occurred only on 2 mapped segments. Animal surveys were conducted during two float trips: August 4-11, 2003 (Coal Banks to Judith on August 4-8, Judith to James Kipp on August 8-11), and July 12-17, 2004 (Coal Banks to Judith). Bat surveys were the primary focus both years, but we also documented all amphibian and reptile sightings. Small mammals were also live-trapped during the 2003 trip. Descriptions of specific survey methodologies are given below for the different animal groups; all survey sites and opportunistic encounters were geo-referenced with a GPS unit, or determined with a river map to the nearest quarter-quarter section and river mile below Fort Benton.

Amphibians and Reptiles

Observations of amphibians and reptiles in 2003-2004 were opportunistic; we did not conduct any timed searches for them at specific sample locations, nor did we use any standardized sampling methodology, although seining for fish produced one of the turtle observations. Instead, we documented all amphibians and reptiles we encountered. We were especially vigilant for basking turtles, often scanning beaches, mud flats, exposed rocks and partially submerged logs with binoculars while we floated.

Bats

Bats were captured in 2003 and 2004 using up to six 50-denier mist nets of 18-40ft (6.0-12m) lengths and deployed at woodland sites at or near our camps; we sampled bats at a total of 9 sites, 7 of which were between Coal Banks and Judith landings. We used an electronic bat detector, either Anabat II (Titley Electronics, Ballina, Australia) or Pettersson D240x (Pettersson Elektronik AB, Uppsala, Sweden), to aid in detecting the presence of bats in the area while we operated mist nets; only those sites netted were also monitored with an electronic bat detector. Typically, nets were deployed at dusk and operated for at least 2-3 hours (usually until midnight or later) when conditions were favorable (no more than light winds and no rain). Captured bats were identified with the aid of dichotomous keys (van Zyll de Jong 1985, Nagorsen and Brigham 1993); individuals were sexed, aged, measured (forearm, with a dial caliper to the nearest 0.1 mm), reproductive status noted, marked on the dorsal surface of the uropatagium with a felt-tip marker (to recognized animals already captured in case they were caught again), and released. Statistical analyses of bat sex ratios follow standard nonparametric procedures (Sokal and Rohlf 1981), with statistical significance assumed at $P < 0.05$; analyses were run using Statistix 8 software.

Mussels

Surveys of mussels (*Unionidae*) occurred between Coal Banks Landing and Judith Landing during July 12-17, 2004. Surveys focused on suitable habitat: usually the inside bends of the river, on the downstream side of islands, or in side channels. Aquascopes (glass bottomed buckets) were used for underwater viewing within 1m on each side of a series of timed 50m transects along the longitudinal length of the stream. The number of transects and time sampled depended on suitable habitat (Young 2001).

Mussels (and dead shells) were placed in mesh bags for later processing. Live individuals collected were identified to species, enumerated and released as close as possible to where they were taken in the field. Dead shells were taken back as a collection record later deposited at the Montana Natural Heritage Program and Montana State University. All survey sites were geo-referenced with a GPS unit.

Small Mammals

At the majority of our 2003 campsites we established up to 3 small mammal traplines each evening, and retrieved the traps the following morning, for a total of 150 trap-nights of effort. Lines were often placed in different habitats at each camp area to increase our chances of capturing a greater diversity of species. Habitat types sampled included silver sage/grass (6), cottonwood (8), mixed juniper/silver sage/limber pine (1). Lines consisted of 10 stations roughly 30 meters apart. At each station we placed a single Sherman live trap baited with rolled oats and a commercial bird seed-mix. A small piece of synthetic cotton was placed in each trap to prevent trap mortality from exposure. Captured animals were identified, sexed, and released.

Data Compilation and Analysis

Each plant species was coded as native or non-native. Canopy coverage of all herbaceous species within each plot were relativized to a scale of 0 to 1 so that the amount of relative coverage attributed to exotic species could be calculated. A value of 1 for exotic species coverage indicates that all of the herbaceous cover within a plot was due to exotic species. Native species richness (the total number of native species present on a plot) was calculated for each plot in herbaceous, woody, and total categories. When individual woody species occurred within more than one structural layer, their canopy coverages were relativized by plot and added together to create a combined coverage variable that was used in some vegetation analyses.

Two indices were created to reflect the qualitative condition of vegetation at each plot. A richness/exotic index was calculated by dividing total native species richness by the relativized herbaceous exotic coverage value at each plot. High values of this index typically indicate high cover of exotic species and lower numbers of native species. A structural diversity index was calculated by multiplying total woody cover by the number of woody structural layers that had cover values >1%. High values of this index indicate that most of the seven possible layers are present and there is significant cover in several of the layers. The Shannon and Simpson diversity indices and species evenness were also calculated for this purpose (McCune and Grace 2002). Because the diversity and evenness measures accord higher value to an even distribution of values, the structural diversity index was judged a better indicator of structural complexity and habitat value.

All plots were ranked in order of scores for the richness/exotic and the structural diversity indices. These rankings were then added together for a combined rank value that was then again ordered for all plots. The end result is a numerical rank for each of the 154 plots in three categories: richness/exotic, structural diversity, and combined richness/exotic – structural diversity (Appendix C - Table 2 and Table 3).

Three vegetation data sets were created: 2003 plots, 2004 plots, and combined. The data sets were created separately so that the different sets of environmental data collected during the two years could be correlated with any patterns in vegetation. Pc-Ord (McCune and Grace 2002) was used to evaluate vegetation patterns and any environmental relationships in the data. Species that occur in only a few plots are not helpful in determining vegetation patterns, thus species that occurred in less than 5% of sample plots were eliminated from subsequent analyses (McCune and Grace 2002). This reduced the number of plant species from 144 to 64. The vegetation data was next examined statistically for plots that were so different from the main data set that including them would skew the results; three plots were removed from the combined data set for this reason, leaving 151 plots for the analysis.

Nonmetric multidimensional scaling was the ordination process used to assess the similarity of vegetation plots (McCune and Grace 2002). This technique orders plots (and species, if desired) along axes that can be viewed to examine any obvious patterns. Correlations with species and environmental variables were calculated to evaluate the strength of the relationship between vegetation pattern, individual species, and environmental factors.

Cluster analysis was used to hierarchically split the vegetation data into progressively finer groups of plots with similar vegetation. Hierarchical clustering does not automatically determine the number of clusters that are interpretable. Indicator species analysis (ISA) was used to provide an objective criterion for making that determination. ISA identifies species that are strongly associated with individual clusters. Each species receives an indicator value based on its abundance and frequency of occurrence within clusters. Monte Carlo tests are then used to test the strength of these associations. ISA was repeated for each level of clustering. The number of clusters with the most robust indicator species was determined to be the most ecologically meaningful (McCune and Grace 2002). Plots were also clustered using existing riparian plant community types (Hansen 1989). Clusters were then examined for their correlation with abiotic variables. Multi-response Permutation Procedure (MRPP) was used to determine whether vegetation patterns were strongly related to either the riparian mapping types or the grazing accessible types identified in 2004.

Vegetation-environment relationships were further evaluated using classification and regression tree models (CART (Systat Software 2004)). This analysis determines the most important factors predicting the percentage of exotic herbaceous cover, native species richness, and structural diversity. CART models also were applied in an evaluation of variables best predicting cluster or mapping type membership. CART models can be evaluated using a proportion of reduction in error (PRE) number. PRE ranges from 0 to 1, with 1 indicating a perfect fit. Variables continue to be entered until the addition to the PRE number is <0.05. The relationship between many vegetation and environmental variables was also examined with a Spearman rank correlation analysis generating r_s values.

Results and Discussions

Animal Groups

During our surveys we documented two amphibian species, five reptile species, five bat species, and five small mammal species (Table 2). Four of these species (one in each group) are Montana Animal Species of Concern, and those plus the long-eared myotis (*Myotis evotis*) are considered BLM Sensitive. Results for each group are summarized and discussed below.

Amphibians and Reptiles

Seven species of amphibians and reptiles were detected on this segment of the Missouri River (Table 2). Evidence of reproduction by amphibian species (Woodhouse's toad, northern leopard frog) included metamorphs and juveniles of each. Toad metamorphs were found only in August, while metamorphic leopard frogs were present in July. Both species were fairly abundant in the Wild and Scenic portion of the Missouri River corridor, and these were the only amphibians documented by Flath (2003) in the same portion of the Missouri River corridor (Virgelle to Judith Landing). Both species were apparently widespread historically in the state (Cope 1879, Mosimann and Rabb 1952, Black 1971, Maxell *et al.* 2003), and remain relatively common across the Great Plains of Montana (Maxell *et al.* 2003, Werner *et al.* 2004). However, the northern leopard frog has experienced dramatic declines west of the Continental Divide for reasons not entirely clear (Werner 2003). Current management along the Wild and Scenic corridor appears to be sufficient for maintaining populations of both amphibian species.

Table 2. Amphibian, reptile, bat, and rodent species detected in August 2003 and July 2004 on the Missouri River between Coal Banks Landing and James Kipp State Park, Montana. Corresponding global (G) and state (S) numeric ranks are listed for each, with bold type indicating Animal Species of Concern for Montana (Montana Natural Heritage Program 2004); BLM Sensitive Species (as of July 2004) are indicated with an S.

Common Name	Scientific Name	Global Rank[a]	State Rank[a]	BLM Rank	Detection Method[b]
Amphibians					
Woodhouse's toad	*Bufo woodhousii*	G5	S4		C, O
northern leopard frog	*Rana pipiens*	G5	S3	S	C, O
Reptiles					
spiny softshell	*Apalone spinifera*	G5	S3	S	C, O
painted turtle	*Chrysemys picta*	G5	S4		C, O
gophersnake	*Pituophis cantenifer*	G5	S5		O
plains gartersnake	*Thamnophis radix*	G5	S4		O
western rattlesnake	*Crotalus viridis*	G5	S4		O
Bats					
Townsend's big-eared bat	*Corynorhinus townsendii*	G4	S2	S	C
big brown bat	*Eptesicus fuscus*	G5	S4		C
western small-footed myotis	*Myotis ciliolabrum*	G5	S4		C
long-eared myotis	*Myotis evotis*	G5	S4	S	C
little Brown myotis	*Myotis lucifugus*	G5	S4		C
Small Mammals (Rodents)					
beaver	*Castor canadensis*	G5	S5		O
muskrat	*Ondatra zibethicus*	G5	S5		O
deer mouse	*Peromyscus maniculatus*	G5	S5		C
least chipmunk	*Tamias minimus*	G5	S4		O
black-tailed prairie dog	*Cynomys ludoviscianus*	G4	S3	S	O

[a] see Appendix A for Heritage/FWP rank definitions.
[b] Captured (C), Observed (O).

We encountered five species of reptiles during our trips, including painted turtles in both years (Coal Banks Landing and Little Sandy Creek), gophersnake in both years (in the vicinity of Eagle Creek), plains gartersnake once in 2003 (a few miles above Eagle Creek), and western rattlesnake at two locations in 2003 (near Eagle Creek and opposite Dark Butte).

By far, the most common reptile species we saw was the spiny softshell turtle throughout the river corridor between Coal Banks and Judith landings both years: 24 observations in 2003 and 21 in 2004. The spiny softshell is a Montana Animal Species of Concern and BLM Sensitive Species (Table 2). A hatchling captured on July 16, 2004 indicated that the population is reproducing. Lewis and Clark first reported the spiny softshell in Montana at the mouth of present-day Bullwhacker Creek in 1805, upstream from James Kipp State Park (Maxell *et al.* 2003). With this long history of occurrence in the Wild and Scenic Missouri River corridor, it is encouraging that the spiny softshell continues to be present in significant numbers, even though the population above Ft. Peck Reservoir appears to be reproductively isolated, as is the Yellowstone River population (Maxell *et al.* 2003, Werner *et al.* 2004). Within the Wild and Scenic corridor, current management appears to be sufficient for maintaining populations of this species, which requires exposed sandy sites for laying eggs. Current river dynamics along the Wild and Scenic appear to maintain sufficient nesting habitat, although this should be quantified and monitored.

Bats

Five species of bats were captured, numbering 43 individuals (Appendix C - Table 4). Townsend's big-eared bat, a Montana Species of Concern and BLM Sensitive Species, was captured at one site. Long-eared myotis, a BLM Sensitive Species, was captured at five sites. Other bat species documented include big brown bat from one site, western small-footed myotis from two sites, and little brown myotis at six sites. Altogether, bats were captured at eight of nine camps where we deployed nets; all netting sites were in isolated cottonwood stands under the tree canopy. Unidentified bats were seen at the ninth site (White Rocks) on 13 July 2004, but strong winds prevented their capture.

Four other bat species are known to be present during summer along the Wild and Scenic Missouri include silver-haired bat (*Lasionycteris noctivagans*), hoary bat (*Lasiurus cinereus*), fringed myotis (*Myotis thysanoides*), and long-legged myotis (*M. volans*) (Cori Lausen, personal communication). In addition, the eastern red bat (*Lasiurus borealis*), a species only recently confirmed in Montana (Foresman 2001), likely uses the corridor during autumn migration; one of the two confirmed records (September 1998) is near Big Sandy.

Evidence of breeding (pregnant females, lactating or post-lactating females, or volant juveniles) was documented at four sites between Coal Banks and Judith landings for all species except Townsend's big-eared bat (Appendix C - Table 4). Breeding has been documented for all bat species known from this area, except the long-legged myotis (Cori Lausen personal communication). Lausen captured lactating female Townsend's big-eared bats in the Coal Banks area and near McClelland Ferry in July 2003.

Our captures included more adult females (58.8%) than adult males (41.2%) (Table 3), however this difference was not statistically significant, probably due to small sample size. Bat surveys conducted by Cori Lausen in 2003 along the Wild and Scenic Missouri (including the Coal Banks and Virgelle areas, Judith Landing, and McClelland Ferry area), with a much larger sample for the same five species (n = 460), showed a slight (but statistically significant) bias in favor of females (55.4%).

In upland areas of Montana, adult males of the same five bat species tend to be more abundant than females (Worthington 1991, Hendricks *et al.* 2000, Hendricks *et al.* 2004). For example, 96 adults of these five species captured in July and August from the Pryor Mountains (Hendricks *et al.* 2004) showed a statistically significant sex ratio favoring males (59.4%) over females (40.6%) —

Table 3. Bats captured during August 2003 and July 2004 in the Wild and Scenic Missouri River corridor.

Species[a]	**Adult**		**Juvenile**	
	Male	**Female**	**Male**	**Female**
Corynorhinus townsendii	---	2	---	---
Eptesicus fuscus	---	1	---	---
Myotis ciliolabrum	2	2	---	2
Myotis evotis	4	8	1	---
Myotis lucifugus[b]	8	7	2	3
Total	14	20	3	5

[a] See Table 2 for common names.

[b] One individual, not included in the table values, escaped before it was sexed and aged.

almost the opposite of our sample for the Wild and Scenic Missouri.

From a landscape perspective, there may be a biological reason for the apparent greater abundance of female bats in the Missouri River corridor. Many bat species found in Montana roost in trees (Adams 2003), and adult females tend to select different roost sites than males during the summer reproductive season, seeking conditions (temperature, relative humidity, food abundance) that are most favorable for raising young (Bogan *et al.* 1996, Cryan *et al.* 2000, Adams 2003). Several bat species make maternity roosts in tree cavities excavated by woodpeckers or under loose bark (Mattson *et al.* 1996, Vonhof and Barclay 1996), which are most frequent in larger, older trees and in stands with a mature canopy layer. Other maternity roosts are in rock crevices in exposed locations (Lausen and Barclay 2002, Chruszcz and Barclay 2003), but even females of crevice-dwelling species sometimes use tree roosts.

The evidence summarized here suggests that the Missouri River may function as a significant breeding area for several species of bats, because the mature cottonwood stands provide an abundance of roosting and high-quality foraging habitat that is especially important for reproductive females. In many locations, important foraging and night-roosting habitat is found near potential day-roosting habitat, and may account for the presence of some species along the river. Townsend's big-eared bat, which rarely uses trees for maternity roosts (Adams 2003), may occur in the Wild and Scenic stretch solely because of the proximity of crevice-roosting and woodland-foraging habitats. Thus, maintaining the processes that maintain tree establishment and stand structural diversity of the Wild and Scenic Missouri River corridor will benefit not only the riparian bird community (Scott *et al.* 2003), but also the bat community that depends on this corridor for roosting and foraging habitat.

Mussels

We found evidence (live or recent dead shells) of 2 species, the fatmucket, *Lampsilis siliquoidaea* and the black sandshell, *Ligumia recta* at virtually all survey sites (Figure 2, Appendix C - Table 5). Two sites had substantial fatmucket beds with 32 and 50 mussels/hr reported. The giant floater (*Pyganodon grandis*) was found at 2 sites with just 1 live specimen at each site. This species prefers the softest sediments (silted side channels); the mainstem Missouri River is not ideal habitat and we would not expect large numbers of this species to be present. These are the three mussel species

Figure 2. Fatmucket (top three) and black sandshell (bottom) mussels.

that have been previously reported from the Missouri River, a total of five species have been documented to occur in Montana.

Mussels are an important food source for aquatic and terrestrial animals. Furbearers such as the raccoon, muskrat, and otter utilize mussels extensively as food. Although only a few fish species extensively utilize mussels directly as food, many other species benefit because filter-feeding mussels discard undigested material, which becomes food for other stream invertebrates that are prey for fish. Mussels as filter feeders also contribute greatly to water quality by removing suspended particles of sediment and detritus.

Small mammals (Rodents)

In 150 trap-nights of effort we captured 29 deer mice (*Peromyscus maniculatus*), for a capture rate of 19.3/100 trap-nights. Mice were captured on 14 of 15 trap-lines in all habitats except silver sage/grassland, and were present at all campsites where we trapped. The deer mouse is one of the most common and cosmopolitan small mammals in North America, as well as in Montana (Morton and Chilgren 1980, Foresman 2001, Pearson *et al.* 2001).

These trap-line results were disappointing, but not entirely unexpected. Populations of mice undergo dramatic fluctuations (Krebs 1996), and many species could have been at low levels. However, it is more likely deer mice are particularly abundant in riparian habitats along the Missouri River. In contrast to our results along the Missouri River, the capture rate of deer mice in 2772 trap-nights in the Centennial Valley Sandhills of Beaverhead County (Hendricks and Roedel 2001) was 1.84/100 trap-nights of effort, or only about 1/10 the trap success along the Missouri River. In CRP lands of Pondera and Teton counties, capture rates of deer mice ranged from 0.125-1.590/100 trap-nights (Rauscher and Kissell 1996), again less than 1/10 our capture rate along the river. A high density of deer mice along the river could quickly occupy traps that might have been accessible to species of lesser abundance. In conjunction with live traps, the use of pitfall traps for shrews and Museum Special snap traps for all small mammal species would increase the likelihood of capturing more species. Space and load limitation of our boat due to netting supplies for bats prevented us from taking additional traps for small mammals. More traps of a wider variety of types should be deployed during any additional survey work for small mammals in the Wild and Scenic corridor.

No other small mammals were captured, although four other small mammal species were infrequently observed (Table 2). Evidence of recent beaver activity (foraging sign, downed trees, lodges) was present in many locations along the river, but we saw only one animal, near mile 81.5 on July 16, 2004. Likewise, a single muskrat was seen in Eagle Creek on August 4, 2003, although habitat suitable for this species is present in many locations. Least chipmunk was noted at one campsite on the south bank at mile 80.5 on August 7, 2003. Adjacent to the cottonwood grove at this site was a large black-tailed prairie dog colony, measuring about 580 by 100 meters. A second prairie dog colony of roughly the same dimensions was observed on the north bank a mile downriver. Because of the very limited survey effort for mammals, some species likely to be abundant in the corridor undoubtedly went undetected (e.g., bushy-tailed woodrat, *Neotoma cinerea*), as did some less abundant species (e.g., olive-backed pocket mouse, *Perognathus fasciatus*).

Vegetation Communities

Native vegetation communities respond to major environment factors, disturbance, and succession in relatively predictable ways. If managers have this knowledge they can identify how management or natural processes will change stand composition or other vegetation characteristics. In this case most of the vegetation pattern depended primarily on the relatively random dominance of one exotic weed or another. Weeds are generalists and can successfully dominate in a variety of site conditions. Likewise, the analysis showed that riparian mapping types are not very useful as an indicator of overall vegetation composition and cover.

The plants species that were most strongly correlated to overall vegetation patterns were smooth brome (*Bromus inermis*) and western snowberry (*Symphoricarpos occidentalis*). These common and widespread plants tended to indicate different vegetation species groups; when smooth brome dominated snowberry was less common and vice-versa. Medium shrub and exotic cover had the strongest correlation to vegetation patterns when exotic cover, structural class cover, and bare soil variables were considered.

Overall, these results underscore the strong impact that exotic plants have had on these vegetation communities, which now are mostly quite different in cover and composition compared to reference descriptions of types that could be expected in this setting (NatureServe 2002, Appendix B). Typically noted in descriptions of these reference types is the presence of relatively diverse and dense shrub layers.

Vegetation Composition: Native and Nonnative Plants

Plant Species of Concern, Species Richness and Nonnative Plants

No plant Species of Concern were found.

Species richness is the number of plant species occurring on a plot. Diversity in a strict sense is richness in species (Whittaker 1972), although there are several other measures of diversity that consider the evenness of species distribution. Species richness was calculated for both natives and for total species numbers, including exotics (Table 4). More than half of the herbaceous species richness is from exotic plants, while the woody species richness is predominantly native plants.

Our analysis found that reduced species richness was most strongly correlated with greater exotic herb cover. Exotic herb cover also had the strongest correlation (negative) to native woody species richness although the relationship was weaker. Only a few environmental variables were available in the 2003 dataset, and none related strongly to species richness or herb exotic cover. Some other variables, like structural layer richness, weren't included in the analysis since they are directly related to overall species richness.

These results suggest direct competition between native and exotic herbaceous plants, with exotic dominance related to the disappearance of native species. The weaker correlation between exotic cover and woody native species richness may indicate little competitive effect of exotics on a variety of woody species or, more likely, a greater time lag between increasing dominance of exotics and the decline of longer-lived woody species.

The 2004 data set had additional soil and other environmental variables to relate to exotic herb cover, but results were similar with a relatively strong negative relationship between exotic herb cover and native species richness. Exotic herb cover was also negatively correlated to the cover of native low shrubs and the quantity of structural layers with significant cover. As exotic cover increases, native species richness, cover, and structural diversity trend downward in this relatively small sample. In a CART analysis of the variables best predicting native species richness, exotic cover was first and soil texture from 1 to 2 m was the only other variable the model used. As the subsoil becomes heavier in texture and consequently has more water holding ability, there are generally more native woody species (woody species form the

Table 4. Average Species Richness Per Plot, Total Includes Nonnative Plants.

Category	Average Species Richness
Native Herbaceous	3.6
Total Herbaceous	8.2
Native Woody	5.8
Total Woody	5.9
Native Total	9.4
Total Species Richness	14.1

majority of all native species, Table 4), although the data set is small and the correlation is quite weak.

Nonnative Plants

We found many species of exotic plants to be well established in riparian cottonwood stands along the river corridor. A total of 38 herbaceous exotic plant species were recorded (Table 5); they comprised at least 5% of the total herbaceous plant cover in all plots (154) and over 25% of the herbaceous cover in 95.5% of the plots (Figure 3). The proportion of exotic to total herbaceous cover was over 95% in 56 plots (36% of the total plots), with complete nonnative coverage in 8 plots (5%) (Figure 3).

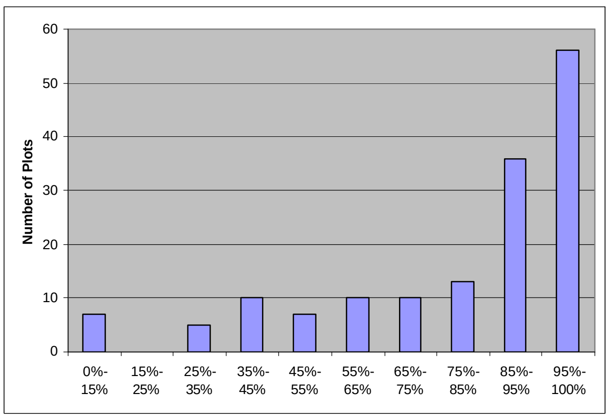

Figure 3. Nonnative herb proportion per plot.

Noxious Weeds

We documented five species designated as Montana noxious weeds in our plots (Table 5). Leafy spurge (*Euphorbia esula*) occurred on over 50% of all plots. It was even more prevalent closer to the river, likely due to the higher water table and more frequent disturbance compared to forested riparian plots on higher terraces. Canada thistle (*Cirsium arvense*) was recorded on 38% of all plots, but with a lower average cover than spotted knapweed (*Centaurea maculosa*), which was documented in 22% of all plots. Diffuse knapweed (*Centaurea diffusa*) and common hound's-tongue (*Cynoglossum officinale* L) were the other two noxious weeds documented. All five species are Category 1 Noxious Weeds capable of rapid spread and causing severe land use impacts (Department of Agriculture 2004).

Smooth Brome and Other Nonnative Grass Species

The most common and abundant exotic was smooth brome, occurring in 106 plots (69%), often dominating the herb layer (Figure 4). Other non-native grass species, such as Kentucky bluegrass (*Poa pratensis*), quackgrass (*Agropyron repens*), crested wheatgrass (*Agropyron cristatum*), and annual bromes (*Bromus* spp.), were also common. Smooth brome is not considered noxious in Montana but is an aggressive and highly competitive species that can spread by seeds or rhizomes and exclude virtually all other species (Blankespoor and Larson 1994). The strong correlation shown here between increasing cover of exotics and declining richness of native herb species emphasizes the significant impact smooth brome can have on community composition and diversity. Similar results were found by Wilson and Belcner (1989) in a Manitoba mixed-grass prairie where species richness in native prairie plots was twice that of stands dominated by smooth brome and other nonnative invaders. They also found that some bird species were significantly more abundant in native vegetation and that no bird species were more abundant in introduced vegetation. They attributed the differences in bird habitat to the lack of insects associated with some exotic plants and the structure of the introduced vegetation, in which the most abundant species, including smooth brome, tended to form a tall homogeneous habitat lacking in the structural diversity favored by many species of birds.


Figure 4. Typical mature cottonwood stand with no shrubs and dominant smooth brome ground cover.

Table 5. Nonnative species occurring on plots.

Common Name	Scientific Name	Mean raw cover	Occurrences	% Plots occurring in	Noxious category
Smooth brome	*Bromus inermis* Leyss.	26.18	106	68.83	
Kentucky bluegrass	*Poa pratensis* L.	11.22	82	53.25	
Quackgrass	*Elymus repens* (L.) Gould	9.49	67	43.51	
Leafy spurge	*Euphorbia esula* L.	9.19	78	50.65	1
Yellow sweet-clover	*Melilotus officinalis* (L.) Lam.	5.37	58	37.66	
Crested wheatgrass	*Agropyron cristatum* (L.) Gaertn.	2.19	25	16.23	
Cheat Grass	*Bromus tectorum* L.	1.60	12	7.79	
Japanese Brome	*Bromus japonicus* Thunb. Ex Murr.	1.53	30	19.48	
Spotted knapweed	*Centaurea biebersteinii* DC.	1.34	34	22.08	1
Intermediate wheatgrass	*Thinopyrum intermedium* (Host) Barkworth & D.R. Dewey	0.89	11	7.14	
Canada thistle	*Cirsium arvense* (l.) Scop.	0.83	59	38.31	1
Common burdock	*Arctium minus* (Hill) Bernh.	0.54	7	4.54	
Hound’s-tongue	*Cynoglossum officinale* L.	0.34	20	12.99	1
Tumblemustard	*Sisymbrium altissimum* L.	0.29	25	16.23	
Poison hemlock	*Conium maculatum* L.	0.29	5	3.25	
Loeselii tumblemustard	*Sisymbrium loeselii* L.	0.27	5	3.25	
Redtop	*Agrostis stolonifera* L	0.18	8	5.19	
Whiet sweet clover	*Melilotus alba* Medikus	0.09	10	6.49	
Reed canarygrass	*Phalaris arundinacea* L.	0.09	5	3.25	
Goatsbeard	*Tragopogon dubius* Scop.	0.04	13	8.44	
White clover	*Trifolium repens* L.	0.04	3	1.95	
Canada bluegrass	*Poa compressa* L.	0.04	2	1.30	
Diffuse knapweed	*Centaurea diffusa* Lam.	0.03	3	1.95	1
Common mullein	*Verbascum thapsus* L.	0.03	9	5.84	
Clover	*Trifolium* spp.	0.02	2	1.30	
Lenspod whitetop	*Cardaria chalapensis* (L.) Hand.-Maz.	0.02	1	0.65	
Asparagus	*Asparagus officinalis* L.	0.01	4	2.60	
Prickly lettuce	*Lactuca serriola* L.	0.01	4	2.60	
Alfalfa	*Medicago sativa* L.	0.01	2	1.30	
Pigweed	*Amaranthus* spp.	0.01	2	1.30	
Ryebrome	*Bromus secalinus* L.	0.01	2	1.30	
Clasping pepper-grass	*Lepidium perfoliatum* L.	0.01	2	1.30	
Meadow foxtail	*Alopecurus pratensis* L.	0.00	1	0.65	
Field morning glory	*Convolvulus arvensis* L.	0.00	1	0.65	
Rabbitfoot polypogon	*Polypogon monspeliensis* (L.) Desf.	0.00	1	0.65	
Sorrel, dock	*Rumex* spp.	0.00	1	0.65	
Dandelion	*Taraxacum officinale* G.H. Weber ex Wiggers	0.00	1	0.65	

In Northwestern Montana, Cooper (2003) found centripetally expanding infestations of smooth brome that had virtually eliminated native prairie vegetation and threatened the habitat of Spalding's catchfly (*Silene spaldingi*), a Montana plant Species of Concern. Butterfield *et al.* (1996), in a ranking of highly disruptive exotic prairie plants, scored smooth brome 85 on a 100 point scale for significance of impact. They also noted that smooth brome has occupied sites 50 years after initial disturbances and that it has the ability to spread into undisturbed areas. Cultural, chemical, and mechanical control methods have all been used against smooth brome with varying levels of success (Butterfield *et al.* 1996). As with most invasive species, early prevention and control are more effective than trying to eliminate an established stand.

The next most common invasive plant species, Kentucky bluegrass and quackgrass, are also nonnative sod-forming perennial grasses that are highly competitive with native plants. Kentucky bluegrass outcompetes prairie vegetation and can persist in areas regularly disturbed or sites that were disturbed decades ago (Butterfield *et al.* 1996). A limited number of control options exist for Kentucky bluegrass and quackgrass, and require that there be sufficient native vegetation to reclaim the site (Butterfield *et al.* 1996).

Russian Olive

Although herbaceous exotics are well established throughout the Wild and Scenic River corridor, woody exotics are uncommon. Russian olive (*Elaeagnus angustifolia*) was the only nonnative woody species recorded during this study, although Tamarisk (*Tamarix* spp.) occurs downstream and should be monitored closely since it also has large ecological effects in riparian areas. Russian olive is not yet widely distributed through the Wild and Scenic River corridor, occurring in only about 10% of the plots (15 plots) and at low cover. In tributaries of the Missouri, Lesica and Miles (1999) found more Russian olive invasions near domestic plantings. In our study, Russian olive was found mostly in the western half of the river corridor, (Appendix Figure 1), which is largely private land and where there may be plantings that have served as seed sources. The relatively low invasion rate, especially in the downstream half of the Wild and Scenic River corridor, where public ownership dominates, is probably due to the lack of nearby seed sources.

Russian olive is native to southern Europe and to central and southern Asia (Katz and Shafroth 2003). Initially introduced to North America by Midwestern immigrants in the 19th century, it has since been recommended for a variety of uses including wildlife enhancement, windbreaks, and horticultural and reclamation plantings (Katz and Shafroth 2003). It has become naturalized across the western United States and is still being planted (Lesica and Miles 1999). Katz and Shafroth (2003) provide a recent review on Russian olive ecology and management.

Evidence for the value of Russian olive to wildlife is sparse and contradictory (Stoleson and Finch 2001), but generally negative impacts have been reported for native birds. While some bird species do use Russian olive, it leads to habitat degradation for others, like insectivores or cavity nesters (Knopf and Olson 1984, Olson and Knopf 1986). Habitat for insectivores is diminished in Russian olive because there are fewer insects (Kennedy and Wilson 1969) and arthropods (Hudson 2000) compared to native vegetation. This lack of insects will probably have a similar negative effect on bat habitat. Russian olive appears to be inappropriate for all cavity nesters (Stoleson and Finch 2001). Since some species of bats also depend on cavities, there could be considerable long-term impacts on bat populations if Russian olive is allowed to spread and dominate riparian forests.

Native riparian vegetation supports more neotropical migrants, a declining group of birds, than are found in Russian olive stands (Hudson 2000), which also have lower bird species richness and breeding diversity (Knopf and Olson 1984, Brown 1990). Many species of breeding birds do not use Russian olive (Stoleson and Finch 2001), and few seem to prefer it — Morning Doves, Yellow-breasted Chats (Knopf and Olson 1984, Brown 1990, Stoleson and Finch 2001) and Willow

Flycatcher (Stoleson and Finch 2001). While no detailed studies on the habitat value of Russian olive exist for Montana, Brown (1990) found that in Idaho, bird breeding richness, abundance and density were all greater in native riparian habitat (Brown 1990). Additionally, all foraging guilds avoided Russian olive during the breeding season, and fewer used Russian olive stands in winter (Brown 1990).

Russian olive can affect vegetation composition and structure, eventually resulting in an alteration of the basic successional dynamics of riparian forests (Katz and Shafroth 2003). Unlike the dominant riparian pioneer species, cottonwood and willows, Russian olive can establish under shade and is self replacing. It also may compete strongly with later successional species like green ash and box elder (Lesica and Miles 2001). Decadent stands of cottonwood that would eventually be replaced by non-forested riparian communities will succeed to shrub dominated stands of Russian olive if it is abundant. As Russian olive increases, it can displace native shrubs and later successional trees (Lesica and Miles 2001), eventually forming monotypic stands that fundamentally alter natural ecosystem composition, structure, function, and habitat value.

While livestock graze Russian olive, it is not believed that herbivory will prevent its survival (Katz and Shafroth 2003). Russian olive is also much less preferred by beavers compared to cottonwoods (Lesica and Miles 1999). In a review of control methods, Katz and Shafroth (2003) recommend targeting initial seedling establishment due to the difficulty of achieving control on established plants. Natural river flow regimes may help limit the success of alien invaders (Katz and Shafroth 2003), and Russian olive is more likely to become dominant where the riparian zone is less dynamic (Lesica and Miles 2001). Since Russian olive requires 10 years to reach reproductive maturity and invasion progresses slowly for the first 30 years, Lesica and Miles (2001) suggest that an effective control method could consist of eradicating mature trees every 10 years or all plants every 30 years.

The current absence of Russian olive and seed sources along much of the Wild and Scenic River corridor, coupled with relatively natural flow regimes, may represent an important and time-limited opportunity for managers to actively monitor and control infestations. Otherwise, Russian olive will eventually become established and completely change the ecology and character of the riparian corridor, as it has along so many other rivers.

Richness/Exotic Index

All plots were ranked with the richness/exotic index (Appendix C - Table 3). Since a majority of the total native plant species richness is derived from woody species (Table 4), this index also partially reflects plots with a diverse shrub and tree component. Plots that are highly ranked have more plant diversity and less exotic weed cover. These areas may be more suited for restoration or managers may want to limit uses like campsites or intensive grazing that may lead to weed proliferation through dispersion and/or disturbance.

It is important to note that there may be considerable variation within a stand in regards to the plot index score since stands vary in size from a few acres to several hundred and the plots may or may not be close to each other. Also, nonnative weed coverage is typically patchy. Since six of the stands were sampled in both 2003 and 2004, variation can be compared. The closest ranks within the same stand differed by only one rank (112 to 114), while the greatest discrepancy was a ranking of 63 and 120. Therefore, ranks based on this index are best generalized into approximate groups, (e.g., the upper 25%), since the variability in expanding from a plot to a larger stand may be considerable.

Vegetation Structure

The structure of vegetation has repeatedly been shown to be critical in the distribution and abundance of birds, presumably because it contributes to critical resources such as food, nesting sites, or cover from predators (Rotenberry and Wiens 1980). Scott *et al.* (2003) found that bird species richness and diversity increased with greater structural complexity of vegetation along the Upper Missouri Wild and Scenic River. Bird abundance in canopy and tall-shrub foraging guilds increased significantly with greater tree and tall-shrub cover (Scott *et al.* 2003). Seventeen bird species were associated with complex forest patches while only six species were associated with simple patches (Scott *et al.* 2003).

Woody Structural Layers and the Structural Diversity Index

The quantity of plots and the number of woody structural layers with greater than 1% cover (Figure 5) shows that most stands sampled had only 2 – 4 structural layers out of a possible total of 7. Only 1 stand had 7 layers and almost 10% of the stands only had one woody layer.

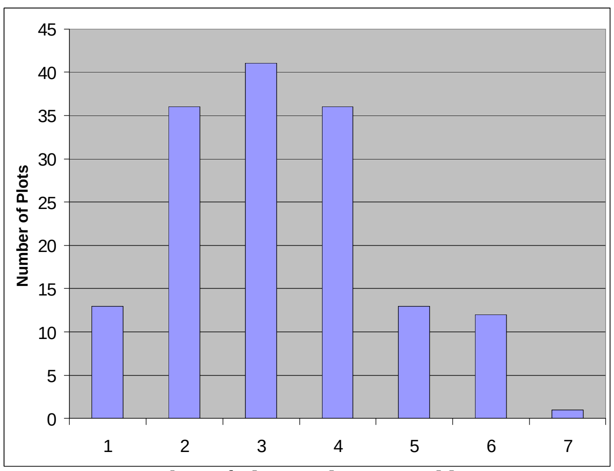

Figure 5. Number of plots and structural layers.

All plots were ranked with the Structural Diversity Index (Appendix C - Table 2). Highly ranked plots will have several structural layers and high overall cover of woody species. This index represents only one way of evaluating vegetation structure; the raw data can be used to develop other ranks that focus on structural layers of interest.

Extrapolation of this plot data to the larger stand may vary for the same reasons as the richness/ exotic index since structural complexity will also change throughout a stand and stands may be of variable sizes, however there was less variation than the range of the richness/exotic index. Rankings within stands were as close as 46 and 57 compared to the most distant at 49 and 71. This indicates that stand structural diversity does not have the variability of exotic weed distribution and probably is more uniform within the stand polygons mapped by Hansen (1989).

Disturbance, Environmental Factors, and Vegetation

Disturbance Effects on Vegetation

Disturbance is particularly important in riparian forests but can have a variety of positive or negative effects depending on the type, timing, and severity of the disturbance. Floods are necessary for cottonwood establishment, but ice impacts can eliminate tree regeneration (Hansen 1989). Livestock activity, fire (Figure 6), beaver harvesting (Figure 7), windthrow, and riverbank erosion (Figure 8) were all observed to have significant impacts on cottonwood trees and ecosystems along the river. Several stands had burns, some severe enough to kill virtually all trees. Considerable mortality from beavers was also noted in many stands; since some of these decadent “stands” had less than 10 trees, beavers could virtually eliminate the stand within a few years if actively harvesting trees in the area.


Figure 6. Cottonwood mortality caused by fire in a common linear stand with few trees.

Our measure of bare ground cover (2003) and livestock accessibility (2004) did not correlate well with any vegetation measures. Disturbance effects are very difficult to evaluate with a one-time

Figure 7. Mortality by beaver is common along the river.

Figure 8. Shifting channels can undercut cottonwood stands.

measurement since past disturbances can have long lasting effects and current disturbances may primarily have future effects. Disturbances at the time of initial exotic plant establishment or early spread stages and the time since these disturbances occurred are likely much more important determinants of current conditions.

Another measure of disturbance was the browse evaluation data from the 2003 plots. There were considerable differences among species and the three maturity classes recognized (Appendix C - Table 6). Since young shrubs are the most accessible and palatable maturity class, viewing browse growth form types for these species (Figure 9) is most informative. Chokecherry (*Prunus*

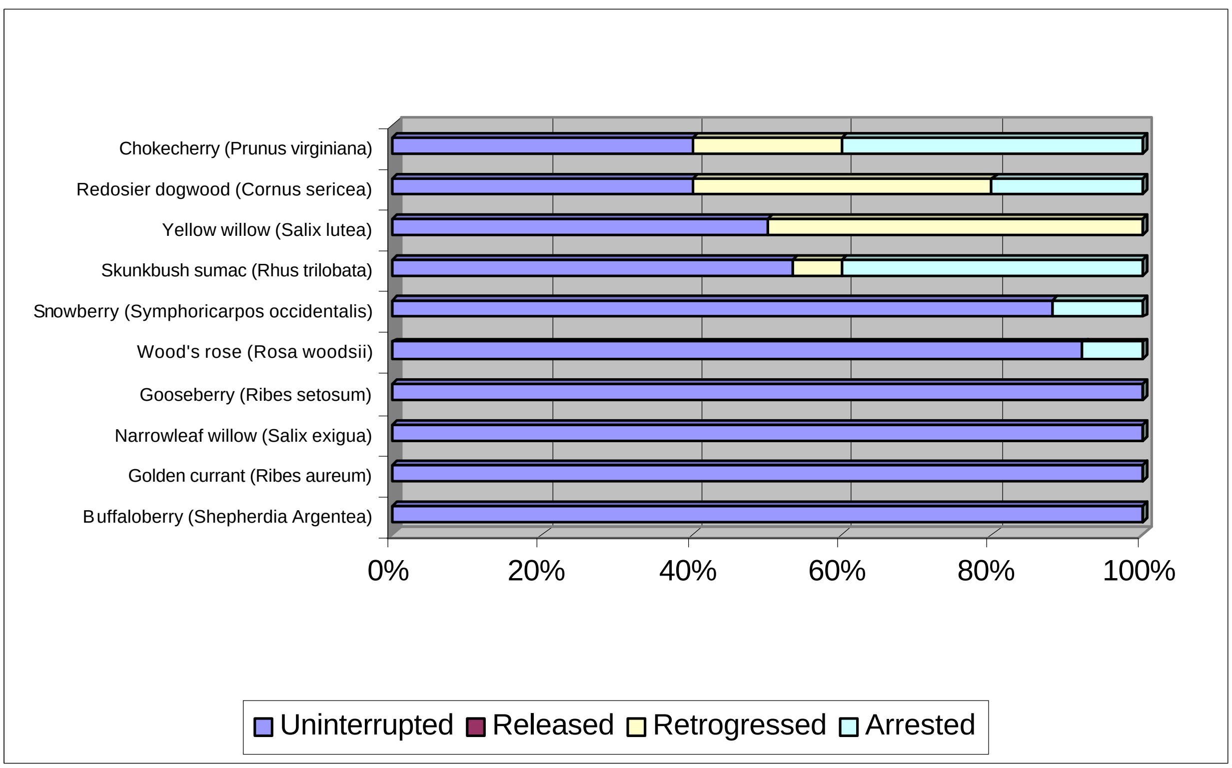

Figure 9. Browse Evaluation for Shrub Species (Young Class) Occurring in >20 Plots.

virginiana L.) and red-osier dogwood (*Cornus sericea* L.) were most affected (Figure 8), with uninterrupted growth form recorded on only 40% or fewer of individuals and a considerable percentage rated as retrogressed or arrested. Chokecherry and red-osier dogwood were also present on only 29 and 20 plots of the 154 total, respectively, suggesting that heavy browsing may be eliminating this species from many stands. Yellow willow (*Salix lutea* Nutt.) and skunkbush sumac (*Rhus trilobata* Nutt.) were also browsed heavily.

Chokecherry, sumac, and dogwood are all berry producing shrubs with significant habitat value for birds and small mammals. They also provide medium to high shrub structure that is important for bird habitat. This high level of browsing on young shrubs could degrade the riparian habitat through immediate impacts to growing shrubs and the habitat they provide. It could also impair future shrub cover by limiting berry production, thereby reducing reproduction.

A relatively undisturbed site along the Wild and Scenic Missouri River should have a diverse, dense understory of red-osier dogwood, western serviceberry (*Amelanchier alnifolia*), chokecherry, willows (*Salix* spp.), currants (*Ribes* spp.), and gooseberries (*Ribes* spp.) (Hansen 1989). As disturbance increases, many of these shrubs will decline as western snowberry (*Symphoricarpos occidentalis*) and rose (*Rosa* spp.) form a thick understory. With more severe disturbance virtually all shrubs will be eliminated and exotic grasses will dominate what becomes a drier site. Hansen (1989) believes that this community will be very difficult to restore and recommends that management be changed before the site is this degraded.

Our survey indicated that very few stands still retained the dense, diverse shrub understory characteristic of relatively undisturbed stands. Many were either totally dominated by nonnative grasses and/or the shrub layer was considerably diminished.

Soils and Terrace Height

There was no strong relationship of soil texture and terrace height to vegetation patterns in the small 2004 data set. Soil textural layers were extremely diverse throughout the 3-meter sampling depth. Alluvial and some erosional deposition from adjacent uplands created these terraces, and a history of different events can be inferred from the many layers typically encountered in the soil profiles. A layer of a consistent texture would sometimes be as thick as 1 meter, but a more typical pattern was a mix of various textures alternating in layers from only a few centimeters thick to several decimeters thick. Most soil profiles included a wide range of textures: sandy loams and loams were most common but sand, silt, and clay were all present, either as dominant textures or in mixtures. Gravel was uncommon.

The height of these forested terraces ranged from 315cm to 650cm above the river (Appendix C - Table 1). The water table was reached within the 3m soil sampling depth in only a few plots, which is surprising since Tyree *et al.* (1994) indicated that cottonwoods grow no more than 4m above the water table and since the soil water table closely tracks the river level (Mahoney and Rood 1991). Given the range of variability in our height data, it's likely that some of these stands are more than 4m above the water table.

The small seeds of cottonwoods do not compete well with established vegetation and generally require favorable microsites created by flood sediments (Braatne *et al.* 1996), although some may establish on newly created sediments caused by slope failures or other events (Scott *et al.* 1997). The soil must stay moist through the early stages of seedling establishment and continue to be favorable throughout the first growing season (Mahoney and Rood 1991). Rates of root growth and seedling establishment are higher in fine textured soils compared to coarse soils (Kocsis *et al.* 1991), which may explain the lack of gravel we found in soil profiles and the relationship (albeit weak) between finer textured soils from 1 – 2m and woody species richness.

Physical disturbance by ice movement eliminates the abundant cottonwood regeneration found on lower terraces (Scott *et al.* 1997). While ice dams can also create flood events along this stretch of the river, Scott *et al.* (1997) conclude that spring floods over 1400m^3/s (measured at Fort Benton), which have an average recurrence interval of about 9 years, create the high terrace seedbeds suitable for cottonwood establishment. Our measurements indicated that terrace height needed to be at least 3m above river level to escape destruction by ice movement (Figure 10).

Scott *et al.* (1997) believe that the upper Missouri Wild and Scenic River stretch is the least hydrologically altered alluvial portion of the Missouri River and still possesses a sufficient hydrologic regime for cottonwood establishment. However, there has been a reduction of up to 50% in large flood pulses (Bovee and Scott 2002). A variety of physically and economically feasible scenarios are discussed by Bovee and Scott (2002) that would help to naturalize flood pulses, establish cottonwood regeneration, and minimize flood damage.

Figure 10. Abundant cottonwood regeneration on lower terrace will eventually be destroyed by ice movement.

Conclusion and Management Recommendations

Riparian forests along the Wild and Scenic Missouri River provide critical habitat for numerous wildlife species but have been severely degraded by human-related disturbance and nonnative plant invasion. This report documents some of the negative effects on plant species diversity, shrub composition, woody structural diversity, and woody growth form (browsing related). Yet, this study also confirmed the persistence of several animal Species of Concern in Montana, indicating opportunities exist in the Wild and Scenic Missouri corridor for proactive habitat conservation and restoration.

Indices were developed that address two key ecosystem values: native species diversity and structural complexity. A combined index was also calculated. All 154 plots were ranked for these three indices (Appendix C - Table 2 and 3). The 25% with the highest combined rank are mapped in Appendix D - D-1 through D-4. These plots indicate stands that are in the best condition for conservation or restoration. While no stands visited were in reference condition, some stands that were ranked highly for native habitat quality could be improved through management to eventually serve as reference sites.

The Wild and Scenic Missouri River corridor is uncommon among large western rivers in retaining enough natural hydrology to regenerate and sustain native riparian forests, although this may need to be actively maintained by interagency cooperation if current conditions change. Large flood events should create new stands that could be managed for native species and structural diversity. Additionally, the eastern half has not been infested with Russian olive and is largely composed of public land isolated from the domestic plantings that provide a seed source. If allowed to infest this area, Russian olive would transform the native riparian ecosystem, significantly altering vegetation composition and structure and degrading habitat for many kinds of birds and bats.

The opportunity to control Russian olive along at least the eastern half of the corridor represents an important and time limited opportunity to maintain relatively natural riparian forests that will continue to provide habitat, recreational and aesthetic values. Tamarisk can also severely damage riparian habitat and, since it is established downstream, monitoring and quick control will be needed to prevent it from becoming established here.

While conversion of riparian forests to Russian olive is known to affect habitat for some species of birds and bats, there no Montana-specific research evaluating its impacts on the entire avian community, bats or small mammals, many of which are Montana Species of Concern. This type of research is needed to identify vulnerable species and assess the threat to their long-term sustainability.

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APPENDIX A. GLOBAL/STATE RANK DEFINITIONS

HERITAGE PROGRAM RANKS

The international network of Natural Heritage Programs employs a standardized ranking system to denote global (range-wide) and state status. Species are assigned numeric ranks ranging from 1 to 5, reflecting the relative degree to which they are "at-risk". Rank definitions are given below. A number of factors are considered in assigning ranks — the number, size and distribution of known "occurrences" or populations, population trends (if known), habitat sensitivity, and threat. Factors in a species' life history that make it especially vulnerable are also considered (e.g., dependence on a specific pollinator).

GLOBAL RANK DEFINITIONS (NatureServe 2003)

G1	Critically imperiled because of extreme rarity and/or other factors making it highly vulnerable to extinction
G2	Imperiled because of rarity and/or other factors making it vulnerable to extinction
G3	Vulnerable because of rarity or restricted range and/or other factors, even though it may be abundant at some of its locations
G4	Apparently secure, though it may be quite rare in parts of its range, especially at the periphery
G5	Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery
T1-5	**Infraspecific Taxon** (trinomial) —The status of infraspecific taxa (subspecies or varieties) are indicated by a "T-rank" following the species' global rank

STATE RANK DEFINITIONS

S1	At high risk because of extremely limited and potentially declining numbers, extent and/or habitat, making it highly vulnerable to extirpation in the state
S2	At risk because of very limited and potentially declining numbers, extent and/or habitat, making it vulnerable to extirpation in the state
S3	Potentially at risk because of limited and potentially declining numbers, extent and/or habitat, even though it may be abundant in some areas
S4	Uncommon but not rare (although it may be rare in parts of its range), and usually widespread. Apparently not vulnerable in most of its range, but possibly cause for long-term concern
S5	Common, widespread, and abundant (although it may be rare in parts of its range). Not vulnerable in most of its range

COMBINATION RANKS

G#G# or S#S#	**Range Rank**—A numeric range rank (e.g., G2G3) used to indicate uncertainty about the exact status of a taxon

QUALIFIERS

NR	Not ranked
Q	**Questionable taxonomy that may reduce conservation priority**—Distinctiveness of this entity as a taxon at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or inclusion of this taxon in another taxon, with the resulting taxon having a lower-priority (numerically higher) conservation status rank

X	**Presumed Extinct**—Species believed to be extinct throughout its range. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered
H	**Possibly Extinct**—Species known from only historical occurrences, but may never-the-less still be extant; further searching needed
U	**Unrankable**—Species currently unrankable due to lack of information or due to substantially conflicting information about status or trends
HYB	**Hybrid**—Entity not ranked because it represents an interspecific hybrid and not a species
?	**Inexact Numeric Rank**—Denotes inexact numeric rank
C	**Captive or Cultivated Only**—Species at present is extant only in captivity or cultivation, or as a reintroduced population not yet established
A	**Accidental**—Species is accidental or casual in Montana, in other words, infrequent and outside usual range. Includes species (usually birds or butterflies) recorded once or only a few times at a location. A few of these species may have bred on the one or two occasions they were recorded
Z	**Zero Occurrences**—Species is present but lacking practical conservation concern in Montana because there are no definable occurrences, although the taxon is native and appears regularly in Montana
P	**Potential**—Potential that species occurs in Montana but no extant or historic occurrences are accepted
R	**Reported**—Species reported in Montana but without a basis for either accepting or rejecting the report, or the report not yet reviewed locally. Some of these are very recent discoveries for which the program has not yet received first-hand information; others are old, obscure reports
SYN	**Synonym**—Species reported as occurring in Montana, but the Montana Natural Heritage Program does not recognize the taxon; therefore the species is not assigned a rank
*	A rank has been assigned and is under review. Contact the Montana Natural Heritage Program for assigned rank
B	**Breeding**—Rank refers to the breeding population of the species in Montana
N	**Nonbreeding**—Rank refers to the non-breeding population of the species in Montana

APPENDIX B. PLANT COMMUNITY DESCRIPTIONS

I.B.2.N.d. Temporarily flooded cold-deciduous forest

I.B.2.N.d.3. *ACER NEGUNDO* TEMPORARILY FLOODED FOREST ALLIANCE

Box-elder Temporarily Flooded Forest Alliance

Concept: Temporarily flooded, early successional forests dominated by *Acer negundo*. This alliance is widespread but sporadic in the southeastern United States, and occurs at scattered locations in the Western Great Plains, lower montane Rocky Mountains, and Intermountain West. Characteristic species include *Platanus occidentalis, Acer rubrum, Liquidambar styraciflua, Acer saccharinum, Ulmus alata, Celtis laevigata*, and *Populus deltoides*. These forests are common on large rivers in the active floodplain and on sandbars. The shrub and herb layers range from sparse to relatively lush, and the vine component often is heavy. Forests dominated by *Carya illinoinensis* often succeed these forests within the range of the species. Pure stands occur on the Mississippi River batture on second ridges with heavy vine cover of *Berchemia scandens* and *Vitis* spp. These forests also occur in the Arkansas River Valley, with marginal examples on larger rivers in the Ouachita Mountains, and the Mississippi River Alluvial Plain, and also in the Nashville Basin of Tennessee and the Bluegrass Basin of Kentucky. Forests dominated by *Acer negundo* occur from near sea level in the Southeast to over 2300 m in elevation in western Colorado. The presence of this alliance in the Southeastern Coastal Plains is apparently somewhat sporadic. It would be expected on the Apalachicola River in Florida and adjacent Georgia.
Comments: Forests dominated by *Carya illinoinensis* often succeed these forests. The rangewide occurrence of this type is complicated by the 'weedy' nature of *Acer negundo*. For example, disturbed stands in the I.B.2.N.d *Fraxinus pennsylvanica* - *Ulmus americana* - *Celtis (occidentalis, laevigata)* Temporarily Flooded Forest Alliance (A.286) often become dominated by *Acer negundo.*
Range: This alliance is widespread across the southeastern United States and occurs at scattered locations in the Western Great Plains, lower montane Rocky Mountains, and the Intermountain West. It ranges from Maryland and Virginia sporadically south through Kentucky, South Carolina, Alabama, and Georgia, and west into Arkansas,

Missouri, and Oklahoma. These forests also occur in the Arkansas River Valley, with marginal examples on larger rivers in the Ouachita Mountains, the Mississippi River Alluvial Plain, the Nashville Basin of Tennessee, and the Bluegrass Basin of Kentucky. Its presence in the Southeastern Coastal Plains is apparently somewhat sporadic. It would be expected on the Apalachicola River in Florida and adjacent Georgia, and the lower Chattahoochee River (Alabama/Georgia stateline). It is also reported from Colorado, Utah, Idaho, Montana, South Dakota, Wyoming, and possibly Arizona.
States/Provinces: AL AR CO GA IA ID KY LA MD MO MS MT OK SC SD TN TX? UT VA WV WY
TNC Ecoregions: 10:C, 18:C, 19:C, 20:C, 25:C, 26:C, 31:?, 32:P, 36:C, 39:C, 40:C, 41:P, 42:C, 43:C, 44:C, 50:C, 53:C, 56:?, 57:?, 58:?, 59:P, 6:C, 9:C
USFS Ecoregions: 221Ha:CCC, 221Hb:CCC, 221Hc:CCC, 221Hd:CC?, 221He:CCC, 221Ja:CP?, 221Jb:CP?, 221Jc:CP?, 222Ca:CC?, 222Cb:CC?, 222Cc:CCC, 222Cd:CC?, 222Ce:CC?, 222Cf:CC?, 222Cg:CCC, 222Ch:CC?, 222Ea:CCP, 222Eb:CCC, 222Ec:CCP, 222Ed:CCP, 222Ee:CCP, 222Ef:CCP, 222Eg:CCP, 222Eh:CCP, 222Ei:CCP, 222Ej:CCC, 222Ek:CCP, 222En:CCC, 222Eo:CCC, 222Fa:CP?, 222Fb:CP?, 222Fc:CP?, 222Fd:CP?, 222Ff:CP?, 231Ba:CCP, 231Bb:CCP, 231Bc:CCP, 231Bd:CCC, 231Be:CCP, 231Bf:CCP, 231Bg:CCP, 231Bh:CCP, 231Bi:CCP, 231Bj:CCP, 231Bk:CCP, 231Bl:CCP, 231Ca:CCP, 231Cb:CCP, 231Cc:CCP, 231Cd:CCC, 231Ce:CCP, 231Cf:CCP, 231Cg:CCP, 231Da:CCP, 231Db:CCP, 231Dc:CCP, 231Dd:CCP, 231De:CCP, 231Ea:CC?, 231Eb:CCP, 231Ec:CC?, 231Ed:CCP, 231Ee:CCP, 231Ef:CCP, 231Eg:CCP, 231Eh:CCP, 231Ei:CCP, 231Ej:CCP, 231Ek:CCP, 231El:CCP, 231Em:CCP, 231En:CCP, 231Fa:C??, 231Fb:C??, 231Ga:CCC, 231Gb:CCC, 231Gc:CCC, 232Bj:CP?, 232Bs:CPP, 232Dc:CP?, 234Aa:CCC, 234Ab:CCC, 234Ac:CCC, 234Ad:CCC, 234Ae:CCC, 234Af:CCC, 234Ag:CCC, 234Ah:CCC, 234Ai:CCC, 234Aj:CCC, 234Ak:CCC, 234Al:CCC, 234Am:CCC, 234An:CCC, 331D:CC, 331G:CC, 341B:CC, 342A:CC, 342B:CC, 342G:CC, M221Cd:CCC, M231A:CC, M331B:CC, M331D:CC, M331G:CC, M331H:CC, M334A:CC, M341B:CC
Federal Lands: COE (Arkansas River); NPS (Jewel Cave, Russell Cave, Shiloh, Wind Cave); USFS (Black Hills, Daniel Boone, St. Francis, Tuskegee); USFWS (Holla Bend, Little River)
Synonymy: Riverfront Forest, in part (Foti 1994b); Alluvial forest, in part (Evans 1991); *Acer saccharinum* forest alliance. ? (Hoagland 1998a); R1B3cI1a. *Acer negundo* - *Carya illinoiensis* - *Populus deltoides* (Foti et al. 1994); Boxelder (*Acer negundo*) Dominance Type, in part (Jones and Walford 1995); *Acer negundo* Community Type, in part (Szaro 1989); *Acer negundo*-Mixed Deciduous Community Type, in part (Szaro 1989)
References: Evans 1991, Faber-Langendoen et al. 1996, Foti 1994b, Foti et al. 1994, Hansen et al. 1988b, Hansen et al. 1991, Hansen et al. 1995, Hoagland 1997, Hoagland 1998a, Jones and Walford 1995, Kittel and Lederer 1993, Kittel et al. 1994, Kittel et al. 1999a, Padgett et al. 1989, Richard et al. 1996, Szaro 1989, Youngblood et al. 1985a
Authors: D.J. ALLARD, MOD. D. CULV, MP, Southeast **Identifier:** A.278

Acer negundo / Prunus virginiana Forest **G3 (96-02-01)**
Box-elder / Choke Cherry Forest
Box-elder / Choke Cherry Forest
Ecological Group (SCS;MCS): Northern and Central Great Plains Wooded Riparian Vegetation (560-05; 1.6.5.1)

Concept: This box-elder riparian forest is found on floodplains at warm elevations in the western Great Plains of the United States. This is an early successional community dominated by *Acer negundo*. *Populus deltoides* may also be present. Tree density may be moderate to high. Shrubs are common and vary from short (<1 m) to tall (>2 m). *Prunus virginiana* and *Cornus sericea (= Cornus stolonifera)* are often abundant. At Wind Cave National Park, these woodlands vary in composition, with *Acer negundo* usually present, but *Prunus virginiana* frequently absent. Tree cover typically is in the 10-25% range. Other tree species include *Ulmus americana*, *Quercus macrocarpa*, *Fraxinus pennsylvanica* and *Populus deltoides*. Total shrub cover (tall and short shrubs) is often greater than 50%. Common species, in addition to *Prunus virginiana*, include *Rhus trilobata*, *Symphoricarpos occidentalis*, *Ribes aureum*, and *Rubus pubescens*. Herbaceous cover is variable, but usually less than 50%. Species composition also varies; common species include *Poa pratensis*, *Monarda fistulosa* and *Apocynum cannabinum*. In Colorado, dense thickets of *Prunus virginiana* may occur. When left undisturbed, the shrub canopy can be very thick and nearly impenetrable.
Comments: In the Black Hills, see description by Marriott and Faber-Langendoen (2000).
Range: This riparian forest grows on broad alluvial floodplains at warm elevations in the western and northern Great Plains of the United States, ranging from Colorado to Montana.

States/Provinces: CO:S2, MT:S3, SD:S?, WY:S2S3
TNC Ecoregions: 10:C, 25:C, 26:C, 36:, 9:C
USFS Ecoregions: 331D:CC, 331G:CC, 342A:CC, M331B:CC, M334A:CC, M341B:CC
Federal Lands: NPS (Jewel Cave, Wind Cave); USFS (Black Hills)
Synonymy: *Acer negundo/Prunus virginiana* (Bourgeron and Engelking 1994) =, DRISCOLL FORMATION CODE:I.B.3.d. (Driscoll et al. 1984) B
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Hansen et al. 1991, Hansen et al. 1995, Kittel et al. 1994, Kittel et al. 1999a
Authors: J. Drake, mod. H. Marriott, WCS **Confidence:** 1 **Identifier:** CEGL000628

I.B.2.N.d.15. *POPULUS DELTOIDES* TEMPORARILY FLOODED FOREST ALLIANCE

Eastern Cottonwood Temporarily Flooded Forest Alliance

Concept: This alliance, found throughout the central midwestern and southeastern United States, contains riverfront floodplain forests. The tree canopy is tall (to 30 m) and dominated by *Populus deltoides* and *Salix nigra*, although *Fraxinus pennsylvanica, Acer negundo, Acer rubrum, Acer saccharinum, Platanus occidentalis,* and *Ulmus americana* are also commonly encountered in various parts of this alliance's range. Tree diversity is limited due to the dynamics of flooding and deposition/scouring of sediments. The shrub layer is often sparse, but species such as *Salix exigua, Carpinus caroliniana, Lindera benzoin, Cornus drummondii* and, in the Southeast, *Ilex vomitoria, Ilex opaca var. opaca*, and *Forestiera acuminata* can be found. Herbaceous growth can be thick and lush but is often patchy and sparse due to frequent inundation. Herbaceous species found throughout the range of this alliance are not well known, but in parts of the range, species can include *Carex* spp., *Leersia oryzoides, Bidens* spp., Asteraceae spp., *Eragrostis hypnoides, Lipocarpha micrantha, Rumex maritimus, Potentilla paradoxa,* and, more commonly in the Southeast, *Leptochloa panicea ssp. mucronata (= Leptochloa mucronata)* and *Mikania scandens*.

Stands are found primarily along riverfronts, where they develop on bare, moist soil on newly made sand bars, front-land ridges, and well-drained flats. Soils are formed in alluvium, are deep, medium-textured, and with adequate or excessive moisture available for vegetation during the growing season. This alliance can also be found on abandoned fields and well-drained ridges in the first bottoms.
Comments: In the Midwest, this alliance can overlap floristically with the I.B.2.N.d *Acer saccharinum* Temporarily Flooded Forest Alliance (A.279), particularly where historic flooding regimes have been altered, leading to stabilized substrates and suitable conditions for *Acer saccharinum* and other species less tolerant of floods. Where *Acer saccharinum* is either codominant with *Populus deltoides* or has become the dominant subcanopy species and understory composition reflects the new hydrologic regime, the stand should be placed in that alliance. This alliance is known from Kentucky's Mississippi River Alluvial Plain, where it provides nesting habitat for the Mississippi Kite.
Range: This alliance is found in Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina (?), Oklahoma, South Carolina, Tennessee, Texas, Virginia, Indiana (?), Illinois, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota (?), South Dakota, Wisconsin, Montana, and in Canada, in Saskatchewan. It is likely to occur elsewhere.
States/Provinces: AB AL AR FL GA IA IL IN KS KY LA MB? MN MO MS MT NC? ND NE OH? OK SC SD SK TN TX VA? WI
TNC Ecoregions: 10:C, 25:C, 26:C, 31:C, 32:C, 33:C, 35:C, 36:C, 37:C, 38:C, 39:C, 40:P, 41:C, 42:C, 43:C, 44:C, 46:C, 53:C, 56:C, 57:C, 58:?
USFS Ecoregions: 212Aa:P??, 212Ab:P??, 212Ba:PPP, 212Bb:PPP, 212Ca:PPP, 212Cb:PPP, 212Da:PPP, 212Dc:PPP, 212Ea:PPP, 212Eb:PPP, 212Ec:PPP, 212Ed:PP?, 212Fa:PPP, 212Fb:PPP, 212Fc:PPP, 212Ga:PPP, 212Gb:PPP, 221Aa:PP?, 221Ad:PPP, 221Ae:PPP, 221Af:PPP, 221Ag:PPP, 221Ah:PP?, 221Ai:PPP, 221Aj:PP?, 221Ak:PPP, 221Al:PPP, 221Ba:PPP, 221Bb:PPP, 221Bc:PPP, 221Bd:PPP, 221Db:PPP, 221Ea:PPP, 221Eb:PPP, 221F:PP, 222Ab:CCC, 222Ad:CC?, 222Ae:CC?, 222C:CP, 222D:CP, 222Ee:CP?, 222Ef:CP?, 222Eg:CP?, 222F:CP, 222G:CP, 222H:CP, 222Ia:CPP, 222Ib:CPP, 222Ic:CPP, 222Id:CPP, 222Ie:CPP, 222If:CPP, 222J:CP, 222K:CP, 222Lf:CCC, 222Mb:CCC, 222Me:CCC, 231Aa:CCP, 231Ae:CCP, 231Af:CCP, 231Ak:CCP, 231Al:CCP, 231An:CCP, 231Ap:CCP, 231Ba:CC?, 231Bb:CC?, 231Bc:CC?, 231Bd:CC?, 231Be:CC?, 231Bf:CCC, 231Bg:CC?, 231Bh:CC?, 231Bi:CC?, 231Bj:CC?, 231Bk:CC?, 231Bl:CC?, 231Ca:CP?, 231Cb:CP?, 231Cc:CP?, 231Cd:CP?, 231Ce:CP?, 231Cf:CP?, 231Cg:CP?, 231Ec:CCP, 231Ed:CCP, 231El:CCP,

231Em:CCP, 231F:CP, 231Ga:CCC, 231Gb:CCC, 231Gc:CCC, 232Ad:CPP, 232Bj:CCC, 232Br:CCP, 232Bs:CCC, 232C:CP, 232Fc:CCP, 232Fd:CCP, 234Aa:CCC, 234Ac:CCC, 234Ad:CCC, 234Ae:CC?, 234Af:CC?, 234Ag:CCC, 234Ah:CCP, 234Ai:CCP, 234Ak:CC?, 234Al:CCP, 234Am:CCC, 234An:CCC, 251Aa:CCC, 251Ba:CCC, 251Bb:CCC, 251Cd:CC?, 251Cg:CCC, 251Cq:CCC, 251D:CP, 251Ea:CCC, 251Fa:CCC, 255Aa:CC?, 255Ab:CC?, 255Ac:CC?, 255Ad:CC?, 255Ae:CC?, 255Af:CC?, 255Ag:CCC, 255Ah:CCC, 255Ai:CC?, 255Aj:CCC, 255Ak:CC?, 255Db:CCC, 311A:CC, 331D:CC, 331E:CC, 331F:CC, 331G:CC, 332A:CC, 332B:CP, 332C:CC, 332D:CC, 332E:CC, 342A:??, M212Ac:PPP, M212Ad:PPP, M212Ba:PPP, M212Bb:PPP, M212Ca:PPP, M212Cc:PPP, M212Cd:PPP, M212Da:PPP, M212Db:PPP, M212Dc:PPP, M212Ea:PP?, M212Eb:PPP, M212Fa:PP?, M212Fb:PPP, M221Aa:?PP, M221Ab:?PP, M221Bb:?PP, M221Bd:?PP, M221Be:?PP, M221Bf:?P?, M221Ca:?PP, M221Cb:?PP, M221Cd:?P?, M221Da:???, M331A:CC, M331B:C?, M332D:CC

Federal Lands: COE (Claiborne Lake); NPS (Badlands, Congaree Swamp); USFS (Angelina, Apalachicola, Conecuh, Davy Crockett, De Soto, Delta, Francis Marion?, Holly Springs?, Homochitto?, Kisatchie, Sabine NF, St. Francis?, Sam Houston, Sumter, Tombigbee?); USFWS (Chickasaw NWR, Hatchie, Holla Bend, Lower Hatchie?)

Synonymy: IIA7c. Eastern Cottonwood - Willow Riverfront Forest, in part (Allard 1990); Riverfront Forest, in part (Foti 1994b); Riparian forest, in part (Evans 1991); *Populus deltoides* forest alliance (Hoagland 1998a); R1B3cI2a. *Populus deltoides* (Foti et al. 1994); R1B3cI2c. *Populus deltoides - Salix nigra - Celtis laevigata* (Foti et al. 1994); *Populus-Salix* wetland forest (No. 24), in part (Vankat 1990); Cottonwood: 63, in part (Eyre 1980); *Populus deltoides* Dominance Type, in part (Hansen et al. 1988b)

References: Allard 1990, Ambrose 1990a, Evans 1991, Eyre 1980, Faber-Langendoen et al. 1996, Foti 1994b, Foti et al. 1994, Hansen et al. 1988b, Hansen et al. 1991, Hansen et al. 1995, Hoagland 1998a, Klimas 1988b, MTNHP n.d., Oberholster 1993, Smith 1996a, TNC 1996b, Van Auken and Bush 1988, Vankat 1990, Voigt and Mohlenbrock 1964, Wieland 1994b

Authors: D.J. ALLARD, MOD. D. CULV, MP, Midwest **Identifier:** A.290

Populus deltoides - Fraxinus pennsylvanica Forest **G2G3 (00-02-27)**

Eastern Cottonwood - Green Ash Forest

Cottonwood - Green Ash Floodplain Forest

Ecological Group (SCS;MCS): Northern and Central Great Plains Wooded Riparian Vegetation (560-05; 1.6.5.1)

Concept: This cottonwood - green ash riparian forest community occurs throughout the northern and central Great Plains of the United States and adjacent Canada. Stands occur along rivers and streams and around ponds and lakes. The alluvial soils are variable, with silty clay loam, clay loam, clay, and loam soils in the northern Plains and sandy soils in the central Plains. It is a riparian open to closed-canopy forest dominated by deciduous trees. *Populus deltoides* and *Fraxinus pennsylvanica* are the most abundant mature trees. *Acer negundo* and *Ulmus americana* may also be present in the tree layer. *Juniperus scopulorum* may occur in the western portion of this community's range, and *Juniperus virginiana* in the eastern part. This community is dynamic and in younger stands *Populus deltoides* is the dominant but as stands age *Fraxinus pennsylvanica* becomes more prominent. The shrub layer is often vigorous. Species such as *Rosa woodsii, Symphoricarpos occidentalis, Juniperus scopulorum, Juniperus communis, Prunus virginiana, Cornus drummondii,* and *Cornus sericea ssp. sericea* can be abundant. *Carex* spp., *Juncus* spp., *Leymus cinereus, Lysimachia ciliata, Thalictrum venulosum*, and *Elymus canadensis* are common in the northern Plains, and *Amphicarpaea bracteata, Carex blanda, Geum canadense, Parietaria pensylvanica* and others in the central Plains. Weedy species are almost ubiquitous, especially *Poa pratensis, Bromus inermis, Melilotus officinalis, Ambrosia* spp., and *Urtica* spp.

Comments: In North and South Dakota, woodland cottonwood types may only occur in the western half of the state, e.g., *Populus deltoides / Juniperus scopulorum* Woodland (CEGL002152), where such species as *Celtis occidentalis* do not occur. Further comparisons are needed between these stands and those in Nebraska, which may contain a different set of species.

Range: This cottonwood - green ash riparian forest community occurs throughout the northern and central Great Plains of the United States and adjacent Canada, ranging from the Dakotas northwest to Montana and Saskatchewan, and south to Nebraska.

States/Provinces: MB?, MT:S2Q, ND:S?, NE:S?, SD:S?, SK?

TNC Ecoregions: 25:C, 26:C, 35:C, 36:C
USFS Ecoregions: 251Aa:CCC, 251Bb:CCC, 251Cg:CCC, 331E:CC, 331F:CC, 332A:CC, 332B:CP, 332C:CC, 332D:CP
Federal Lands: NPS (Badlands)
Synonymy: *Populus deltoides / Fraxinus pennsylvanica* Community Type (Girard et al. 1989) =, DRISCOLL FORMATION CODE:I.B.3.d. (Driscoll et al. 1984) B, *Fraxinus pennsylvanica / Symphoricarpos occidentalis* Habitat Type (Hansen et al. 1984) =, *Populus sargentii / Symphoricarpos occidentalis*, Phase 1 Plant Association (Johnston 1987) B, Cottonwood, green ash, boxelder Floodplain Forest (Johnson 1971) =
References: Driscoll et al. 1984, Eyre 1980, Girard 1985, Girard et al. 1989, Hansen et al. 1984, Hansen et al. 1990, Johnson 1971, Johnston 1987, Keammerer 1972, MTNHP n.d., South Dakota Geological Survey n.d., Steinauer and Rolfsmeier 2000
Authors: D. Faber-Langendoen, MCS **Confidence:** 3 **Identifier:** CEGL000658

***Populus deltoides / Cornus sericea* Forest** **G2G3 (00-12-19)**
Eastern Cottonwood / Red-osier Dogwood Forest
Cottonwood / Red-osier Dogwood Forest

Concept: This association is found in the Great Plains of central and eastern Montana, southern Alberta, southern Saskatchewan, and possibly western North Dakota, generally between 550 and 1100 m in elevation. It occurs primarily in the floodplains of major alluvial streams and rivers but may also occur around the margins of lakes and ponds. This is a seral community associated with fluvial processes such as flooding and substrate deposition. It colonizes moist, freshly deposited alluvium and in the absence of further flood disturbance will often develop into *Fraxinus pennsylvanica*- or *Acer negundo*-dominated associations. *Populus deltoides* dominates the overstory, forming an open to closed canopy (average cover is 60%). *Populus balsamifera ssp. trichocarpa, Populus angustifolia,* and *Salix amygdaloides* may be present as subordinate canopy species. The shrub layer is diverse and well-established. *Cornus sericea* is the diagnostic species, and its cover value may vary from 1-90%. Other common shrubs are *Prunus virginiana, Salix lutea, Symphoricarpos occidentalis,* and *Rosa woodsii.* Exotic grasses, such as *Bromus inermis* and *Elymus repens (= Elytrigia repens),* often dominate the herbaceous layer. Common native herbaceous species include *Pascopyrum smithii, Glycyrrhiza lepidota, Maianthemum stellatum,* and *Solidago canadensis.*
Comments: Hansen et al. (1995) base their description of this community on 11 plots. However, only six of these plots would key to *Populus deltoides / Cornus sericea* Forest (CEGL000657). Godfrey et al. (2000) documented an additional 11 plots in Alberta and Saskatchewan, Canada. This community is delimited from *Populus deltoides / Symphoricarpos occidentalis* Woodland (CEGL000660) by the presence of *Cornus sericea* at a cover value greater than 1% (Hansen et al. 1995). *Cornus sericea* is a very palatable shrub, and Hansen et al. (1995) contend that mature stands of *Populus deltoides* that lack or only have trace amounts of *Cornus sericea* cover are grazing disclimaxes. While grazing is certainly an important influence, it is unclear from their research how other factors, such as soils or depth to groundwater, might influence the distribution of *Cornus sericea*.
Range: This community is restricted to the northern portion of the Northern Great Plains Steppe ecoregion of eastern Montana, southern Alberta, southern Saskatchewan, and probably western North Dakota, where it occurs primarily on alluvial terraces along major rivers.
States/Provinces: AB:S?, MT:S2S3, ND?, SK:S?
TNC Ecoregions: 10:C, 26:C
USFS Ecoregions: 331D:CC, 331G:CC, 342A:??, M331A:CC, M331B:C?, M332D:CC
Synonymy: *Populus deltoides/Cornus sericea* (Bourgeron and Engelking 1994) =, DRISCOLL FORMATION CODE:I.B.3.d. (Driscoll et al. 1984) B
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Godfrey et al. 2000, Hansen et al. 1991, Hansen et al. 1995, MTNHP n.d.
Authors: M. Jones, WCS **Confidence:** 2 **Identifier:** CEGL000657

I.B.2.N.d.33. *FRAXINUS PENNSYLVANICA* - (*ULMUS AMERICANA*) TEMPORARILY FLOODED FOREST ALLIANCE

Green Ash - (American Elm) Temporarily Flooded Forest Alliance

Concept:
Comments: The single association in this alliance that is reported for the western U.S. (in eastern Montana and Wyoming) is *Fraxinus pennsylvanica / Prunus virginiana* Forest (CEGL000642). In Montana, this association is considered synonymous with *Fraxinus pennsylvanica* - *Ulmus americana / Prunus virginiana* Woodland (CEGL000643). The relationship between these two associations needs to be reviewed, and they will likely be merged into one association and placed in the *Fraxinus pennsylvanica* - *(Ulmus americana*) Woodland Alliance (A.629). Until this review is completed, the *Fraxinus pennsylvanica* - *(Ulmus americana)* Temporarily Flooded Forest Alliance (A.308) will not be described and may not occur in the West.
Range: This alliance is found in Wyoming, Montana, Minnesota, and North Dakota. It is also found in Manitoba and Ontario, Canada.
States/Provinces: MB MT ND SD SK WY
TNC Ecoregions: 26:C, 34:C, 35:C, 46:C, 47:C
USFS Ecoregions: 251Aa:CCC, 331D:CC, 331F:CC, 331G:CC, 332:P
Federal Lands: NPS (Theodore Roosevelt)
References: Hansen and Hoffman 1988, Hansen et al. 1991, Hansen et al. 1995, Jones 1990
Authors: M.S. REID, West **Identifier:** A.308

Fraxinus pennsylvanica / Prunus virginiana Forest **G3? (96-02-01)**
Green Ash / Choke Cherry Forest
Green Ash / Choke Cherry Forest

Concept:
States/Provinces: MT:S2S3, WY:S2
TNC Ecoregions: 26:C
USFS Ecoregions: 331D:CC, 331F:CC, 331G:CC
Synonymy: DRISCOLL FORMATION CODE:I.B.3.d. (Driscoll et al. 1984) B, *Fraxinus pennsylvanica/Prunus virginiana* (Bourgeron and Engelking 1994) =
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Hansen and Hoffman 1988, Hansen et al. 1991, Hansen et al. 1995, Jones 1990
Authors: WCS **Confidence:** 1 **Identifier:** CEGL000642

II.B.2.N.a. Cold-deciduous woodland

II.B.2.N.a.29. *FRAXINUS PENNSYLVANICA* - (*ULMUS AMERICANA*) WOODLAND ALLIANCE

Green Ash - (American Elm) Woodland Alliance

Concept: This alliance is found along streams and rivers and in draws and canyons across much of the northern Great Plains. Stands often have an overstory that is more dense than typical woodland physiognomy. The canopy can be moderately closed to closed. Most of the canopy trees are 6-10 m tall, and they allow significant light to penetrate to the understory. The shrub layer is usually well-developed while the herbaceous layer is moderately to well-developed. The canopy is dominated by *Fraxinus pennsylvanica* and sometimes *Ulmus americana*. Individuals of *Populus deltoides* and *Acer negundo* are often scattered throughout. The shrub layer is typically dominated by *Prunus virginiana, Symphoricarpos occidentalis, Symphoricarpos albus*, and *Ribes* spp. The herbaceous layer often contains *Maianthemum stellatum*, *Galium aparine*, and *Elymus canadensis*.

Stands of this alliance are usually on flat to moderately steep slopes near permanent or ephemeral streams. Rarely, it can be found on steep north-facing escarpments. These sites create more mesic microclimates in which the

woodland can develop in landscapes otherwise dominated by grasslands. The soils are typically deep and loamy, but in places they can be rocky. Stands are common along riparian areas but are usually distant enough from larger streams that they do not flood or do so for very short periods.
Comments: In places, the elements within the *Populus deltoides* Woodland Alliance (A.1493) border on and succeed to *Fraxinus pennsylvanica - (Ulmus americana)* Woodland Alliance (A.629). Sites that are temporal or spatial transition zones can be difficult to classify.
Range: This alliance is found in the central and western parts of Nebraska, South Dakota, and North Dakota, and in southeastern Montana.
States/Provinces: MT ND NE SD
TNC Ecoregions: 26:C
USFS Ecoregions: 331E:CC, 331F:CC, 332A:C?, 332C:CP, 332D:C?
Federal Lands: NPS (Badlands, Theodore Roosevelt)
Synonymy: Eastern Broadleaf Forests: 98: Northern Floodplain Forest (*Populus-Salix-Ulmus*), in part (Kuchler 1964)
References: Faber-Langendoen et al. 1996, Girard et al. 1989, Hansen et al. 1984, Kuchler 1964, MTNHP n.d., Steinauer 1989
Authors: MCS, MOD. M.S. REID, Midwest **Identifier:** A.629

***Fraxinus pennsylvanica - Ulmus americana / Prunus virginiana* Woodland** **G2G3 (98-06-22)**
Green Ash - American Elm / Choke Cherry Woodland
Green Ash - Elm Woody Draw
Ecological Group (SCS;MCS): Northern Great Plains Ash-Elm Forests and Woodlands (n/a; 2.5.5.3)

Concept: This community type occurs in the northwestern Great Plains of the United States. Stands occur in upland ravines and broad valleys or on moderately steep slopes. They also occurs along small permanent or ephemeral streams, including deep mesic ravines and canyon bottoms that are not flooded or saturated. On these sites, soil and topography permit greater than normal moisture. The soils are clay loams, sandy clay loam, and sandy loam, dry to moist, and moderately well-drained. The parent material is typically colluvium or alluvium. This community is an open- to closed-canopy woodland dominated by *Fraxinus pennsylvanica*. *Ulmus americana* or *Acer negundo* sometimes achieve codominance. In undisturbed stands, the understory is composed of two layers. The taller and more conspicuous layer is a shrub layer 2-3 m tall. This layer is dominated by *Prunus virginiana* with smaller amounts of *Symphoricarpos occidentalis* or more rarely *Ostrya virginiana*. The lower layer is dominated by grasses and sedges such as *Elymus virginicus, Elymus villosus*, and *Carex sprengelii*. Common herbaceous species include *Aquilegia canadensis, Cerastium arvense, Thalictrum dasycarpum, Galium boreale, Galium aparine, Maianthemum stellatum*, and *Thalictrum dasycarpum*. The continuation of the status of *Ulmus americana* as a prominent part of this community is uncertain due to the effects of Dutch elm disease.
Comments: The community described by Girard et al. (1989) in southwestern North Dakota was very dense for a woodland (700 trees/ha); however, the basal area was fairly low (18 m2/ha) and the trees averaged 9 m tall. This appears to be a dense woodland and may overlap with *Fraxinus pennsylvanica / Prunus virginiana* Forest (CEGL000642) that occurs in Montana and Wyoming. For example, the *Fraxinus pennsylvanica - Prunus virginiana* habitat type in Theodore Roosevelt National Park, western North Dakota (Hansen et al. 1985) was expanded in Hansen et al. (1990) to include this community in eastern Montana. Wali et al. (1980) also described a green ash-American elm forest in western North Dakota. Montana lumps most stands with *Ulmus americana* into *Fraxinus pennsylvanica / Prunus virginiana* Forest (CEGL000642).
Range: This community type occurs in the northwestern Great Plains of the United States, from northern and western Nebraska to the Dakotas and Montana.
States/Provinces: MT:S1Q, ND:SU, NE:S2, SD:SU
TNC Ecoregions: 26:C
USFS Ecoregions: 331E:CC, 331F:CC, 332A:P?, 332C:PP, 332D:P?
Federal Lands: NPS (Badlands, Theodore Roosevelt)
Synonymy: DRISCOLL FORMATION CODE:I.B.3.d. (Driscoll et al. 1984) B, *Fraxinus pennsylvanica - Zanthoxylum americanum* (USACE 1979). Similar. In south-central South Dakota along the east bank of the Lake Francis Case

Reservoir on the Missouri River. This type was trampled heavily as domestic animals and wildlife commonly use it for shade from the mid-day sun., Deciduous woods (Tolstead 1947)
References: Daubenmire 1970, Daubenmire and Daubenmire 1968, Driscoll et al. 1984, Girard et al. 1989, Godfread 1976, Godfread 1994, Hansen and Hoffman 1988, Hansen et al. 1984, Hansen et al. 1985, Hansen et al. 1990, MTNHP n.d., Mack 1981, Nixon 1967, Steinauer 1989, Steinauer and Rolfsmeier 2000, Tolstead 1947, USACE 1979, Wali et al. 1980, Williams 1979
Authors: D. Faber-Langendoen, MCS **Confidence:** 2 **Identifier:** CEGL000643

II.B.2.N.b. Temporarily flooded cold-deciduous woodland

II.B.2.N.b.13. *SALIX AMYGDALOIDES* TEMPORARILY FLOODED WOODLAND ALLIANCE

Peachleaf Willow Temporarily Flooded Woodland Alliance

Concept: This alliance is found in the Columbia Basin, northwestern Great Plains, northern Rocky Mountain states, and northeastern Utah along streams and rivers where flooding occurs but is of short duration. It has an open canopy dominated by *Salix amygdaloides*. *Populus deltoides* can also be present. Some stands have a well-developed shrub stratum in which *Salix exigua* is abundant.
Comments: This alliance may possibly be found in the Midwest. It is mostly found in the West and needs rangewide review for a better characterization. Its relationship to the *Populus deltoides* Woodland Alliance (A.1493) where the ranges overlap needs to be worked out, since they seem to occur on similar habitats and have similar overstory species.
Range: This alliance is found from the Columbia Basin to the northwestern Great Plains, south into Wyoming and northeastern Utah.
States/Provinces: ID MT OR SD? UT WA WY?
TNC Ecoregions: 10:C, 19:C, 20:C, 25:C, 26:C, 33:P, 6:C
USFS Ecoregions: 331D:CC, 331F:CP, 331G:CC, 332C:CP, 341C:CC, 342B:CC, 342C:CC, 342I:C?, M331D:CC, M331G:CC, M332A:CC, M332B:CC, M332D:CC, M332E:CC, M332F:CC, M332G:CC, M333B:CC, M333D:CC, M334A:C?
Federal Lands: USFS (Black Hills); USFWS (Lacreek, Ouray)
Synonymy: Peachleaf Willow Dominance Type (Jones and Walford 1995); *Salix amygdaloides* Community Type (Hansen et al. 1995)
References: Faber-Langendoen et al. 1996, Hansen et al. 1991, Hansen et al. 1995, Hinschberger 1978, Jones and Walford 1995, Kittel et al. 1996, Moseley et al. 1992, Welsh et al. 1987
Authors: M. DAMM, West **Identifier:** A.645

***Salix amygdaloides* Woodland** **G3 (96-02-01)**

Peachleaf Willow Woodland

Peachleaf Willow Woodland

Ecological Group (SCS;MCS): Northern and Central Great Plains Wooded Riparian Vegetation (560-05; 1.6.5.1)

Concept: The peachleaf willow woodland type is found in the Northern Rocky Mountains, and possibly into parts of the western Great Plains. Stands occur in riparian areas. The vegetation is dominated by *Salix amygdaloides*.
Comments: In the Black Hills, Peachleaf Willow Woodland has been documented from a single site, along Iron Creek near its confluence with Spearfish Creek. In this stand, peachleaf willow (*Salix amygdaloides*) forms a tall-shrub stratum with Bebb willow (*Salix bebbiana*) and red-osier dogwood (*Cornus sericea*). Stands occur as intermittent patches in a narrow zone along the creek. The overall size is less than 0.5 acre, and peachleaf willow forms a shrubland rather than a woodland. The very limited extent of the type and its atypical structure suggest that Peachleaf Willow Woodland may not be a valid type for the area (Marriott and Faber-Langendoen 2000).

Range: The peachleaf willow woodland type is found in the Northern Rocky Mountains, ranging from Idaho to Montana and possibly into parts of the western Great Plains.
States/Provinces: ID:S2, MT:S3, SD?, WY?
TNC Ecoregions: 19:C, 20:C, 25:C, 26:C, 33:P, 6:C
USFS Ecoregions: 331D:CC, 331F:CP, 331G:CC, 332C:CP, 342B:CC, M331D:CC, M331G:CC, M332B:CC, M332D:CC, M333B:CC, M333D:CC, M334A:C?
Federal Lands: USFS (Black Hills); USFWS (Lacreek)
Synonymy: *Salix amygdaloides* (Bourgeron and Engelking 1994) =, DRISCOLL FORMATION CODE:II.B.3.a. (Driscoll et al. 1984) B
References: Bourgeron and Engelking 1994, Driscoll et al. 1984, Hansen et al. 1991, Hansen et al. 1995, Marriott and Faber-Langendoen 2000, Moseley et al. 1992
Authors: WCS **Confidence:** 1 **Identifier:** CEGL000947

II.B.2.N.a. Temperate cold-blooded deciduous shrubland

III.B.2.N.a.26. *PRUNUS VIRGINIANA* SHRUBLAND ALLIANCE

Choke Cherry Shrubland Alliance

Concept: This alliance occurs in scattered locations at low to mid elevations of the western U.S. Sites typically occur along streams, rivers, lakes and ponds, and on terraces. It also is found in canyons or steep gullies and along arroyos. Elevations range from 716 m to about 1600 m in Montana, Wyoming and Colorado, and up to 2440 m in Nevada. In some places the alliance occurs on side slopes of hillsides, immediately below a seep or spring. Some examples of this alliance have been placed into an intermittently or temporarily flooded hydrologic regime. Soils are usually well-developed, older, and well-drained, formed in shallow to deep alluvial deposits. These soils have higher fertility and afford good rooting depth. Textures range from silt to sandy loams, often becoming skeletal at depth. *Prunus virginiana* can tolerate weakly saline soils, but is intolerant of poor drainage and prolonged flooding. This alliance is characterized by a tall, dense layer of shrubs, primarily of *Prunus virginiana*. In the absence of disturbance, this species can form dense, monotypic thickets. With grazing or browsing disturbance, stands become more open allowing other shrubs to become common, including *Symphoricarpos occidentalis, Rosa woodsii, Ribes aureum*, and, in Oregon, *Sambucus caerulea*. The woody vine *Toxicodendron rydbergii* is present in most stands, as are the forbs *Maianthemum stellatum* and *Galium triflorum*. The herbaceous layer is typically not abundant, although stands with an open shrub canopy will typically have a component of weedy forbs and graminoids. A few scattered *Juniperus scopulorum* also occur.
Comments: The occurrence of *Prunus virginiana* is reported in most literature as being associated with moist soil conditions to semi-riparian. This alliance might be better placed in an intermittently flooded or temporarily flooded formation.
Range: This alliance has been described from the northwestern Great Plains, including eastern Colorado, Wyoming, and Montana. It also is found in low to mid-elevation foothill areas of Idaho, Nevada, Washington and Oregon.
States/Provinces: CO ID MT NV? OR SD WA WY
TNC Ecoregions: 10:C, 20:C, 25:C, 26:C, 6:C
USFS Ecoregions: 331D:CC, 331G:CC, 331H:CC, 342A:CC, 342F:CC, M331B:CC, M331I:CC, M331J:CC, M332B:CC, M332C:CC, M332D:CC, M332E:CC, M333B:CC, M333C:CC, M333D:CC, M334A:CC
Federal Lands: NPS (Badlands, Florissant Fossil Beds, Wind Cave)
Synonymy: *Prunus virginiana* Community Type (Hansen et al. 1995); Common Chokecherry Dominance Type (Jones and Walford 1995)
References: Caicco and Wellner 1983n, Copeland 1980a, Evans 1989a, Hansen et al. 1988b, Hansen et al. 1995, Jones and Walford 1995, Kittel et al. 1996, Kittel et al. 1999a, Manning and Padgett 1995
Authors: M.S. REID, West **Identifier:** A.919

Prunus virginiana - (_Prunus americana_) Shrubland **G4Q (96-02-01)**

Choke Cherry - (American Plum) Shrubland

Choke Cherry - (American Plum) Shrubland

Ecological Group (SCS;MCS): Northern and Central Great Plains Mesic Shrublands (510-55; 2.6.3.2)

Concept: This community has a wide distribution, being reported from states primarily in the northwestern United States, including the northwestern Great Plains, but also in Nevada. In Colorado, this riparian shrubland occurs as small pockets on higher terraces or as narrow bands along the high-water mark of steep banks and incised channels. It can also grow at the base of cliffs adjacent to rivers and streams where it forms impenetrable thickets. Stands have a dense, medium-tall (1.5-2 m) shrub canopy that is almost impossible to walk through. This vegetation is dominated by *Prunus virginiana* and grows at the interface between the riparian areas and the adjacent upland.

At Wind Cave National Park in South Dakota, this type is characterized by moderate to dense shrub cover, typically in the 25-75% range. Shrub cover is generally greater in drainage bottoms and on lowermost slopes, and less on slopes. *Prunus virginiana* may be the dominant shrub species, but often other species are codominant or dominant, especially on slopes, including *Rhus trilobata, Amorpha canescens, Symphoricarpos occidentalis,* and *Toxicodendron pubescens*. Stands dominated by *Prunus americana* may be a variant of this type. In drainage bottom situations, herbaceous cover is usually sparse, less than 10%. On slopes, the shrubs typically occur in some grassland type, and graminoid cover can be greater than 75%.

Comments: The *Prunus virginiana / Rosa woodsii* (common chokecherry / wild rose) community type (Manning and Padgett 1995) is closely related but does not include any *Symphoricarpos occidentalis.*

Range: This shrubland is found primarily in the northern Great Plains and northwestern Rocky Mountain regions of the United States, but may extend into the Great Basin.

States/Provinces: CO:S3, ID:S3, MT:S4, NV?, OR:S3, SD:S?, WA:S2?, WY:S2?

TNC Ecoregions: 10:C, 20:C, 25:C, 26:C, 6:?

USFS Ecoregions: 331D:CC, 331G:CC, 331H:CC, 342A:CC, 342F:CC, M331B:CC, M331I:CC, M331J:CC, M332B:CC, M332C:CC, M332D:CC, M332E:CC, M333B:CC, M333C:CC, M333D:CC, M334A:CC

Federal Lands: NPS (Badlands, Florissant Fossil Beds, Wind Cave)

Synonymy: DRISCOLL FORMATION CODE:III.B.3.a. (Driscoll et al. 1984) B, *Prunus virginiana* (Bourgeron and Engelking 1994) =, *Prunus virginiana* community type (Hansen et al. 1995) =, *Prunus virginiana* Dominance Type (Jones and Walford 1995) =, *Prunus virginiana / Rosa woodsii* community type (Manning and Padgett 1995) F

References: Bourgeron and Engelking 1994, Caicco and Wellner 1983n, Copeland 1980a, Driscoll et al. 1984, Evans 1989a, Hansen et al. 1991, Hansen et al. 1995, Jones and Walford 1995, Kittel et al. 1996, Kittel et al. 1999a, Manning and Padgett 1995, Von Loh et al. 1999

Authors: D. Faber-Langendoen, WCS **Confidence:** 2 **Identifier:** CEGL001108

APPENDIX C. TABLES

Table 1. Soil texture, plot height above river, and grazing accessibility (only measured for 2004 plots).

PLOT#	Soil Texture						Terrace	Grazing
	0–50cm	0–100cm	0–300cm	50–100cm	100–200cm	200–300cm	Height	Accessible?
KC0001	3*	2	3	2	3	4	370	No
KC0002	2	2	2	2	2	1	520	No
KC0003	3	3	3	3	3	4	350	Yes
KC0004	3	2	3	2	4	4	315	No
KC0005	3	2	2	2	2	1	355	Yes
KC0006	3	3	3	2	3	3	390	Yes
KC0007	3	3	2	3	2	1	590	No
KC0008	3	3	3	3	3	2	650	Yes
KC0009	2	3	4	3	3	4	400	Yes
KC0010	4	4	4	4	3	4	350	Yes
KC0011	2	3	2	3	2	2	550	Yes
KC0012	2	2	3	2	3	1	590	Yes
KC0013	3	3	3	3	2	4	390	Yes
KC0014	3	3	3	3	4	3	580	Yes
KC0015	3	2	3	1	2	3	470	Yes
KC0016	3	2	3	1	2	5	475	Yes
KC0017	3	2	3	2	2	4	505	Yes
KC0018	1	2	3	3	3	3	640	No
KC0019	3	3	2	3	2	1	330	Yes
KC0020	3	3	3	1	1	3	590	No
KC0021	3	3	3	3	3	3	480	Yes
KC0022	3	3	3	2	1	2	605	Yes
KC0023	2	3	2	3	2	2	470	Yes
KC0024	3	3	3	3	4	2	570	Yes
KC0025	4	4	3	4	2	2	460	Yes
KC0026	2	3	3	3	3	4	380	Yes
KC0027	5	3	2	3	2	1	370	Yes
KC0028	3	2	3	2	3	3	560	Yes

* Numerical codes indicate the dominant soil texture according to the following classes:
1 = Coarse - sands or loamy sands
2 = Moderately coarse – sandy loam, fine sandy loam
3 = Medium – very fine sandy loam, loam, silt loam, silt
4 = Moderately fine – sandy clay loam, silty clay loam, clay loam
5 = Fine – sandy clay, silty clay, clay

Table 2. Woody canopy cover and structural diversity rank by plot. Shrub and tree class definitions are in Table 1. Structural diversity rank based on number of layers with >1% cover multiplied by total woody cover.

PLOT#	Riparian Mapping Polygon#	Structural Layers with >1% cover	Low Shrub Cover (%)	Medium Shrub Cover (%)	Tall Shrub Cover (%)	Tall Tree Cover (%)	Pole Tree Cover (%)	Small Tree Cover (%)	Sapling Tree Cover (%)	Total Woody Cover (%)	Structural Diversity Rank
EC0001	60	3	13.5	7	0	60	0	0	0	80.5	92
EC0002	77	1	0	0	0	11	0	0	0.5	11.5	153
EC0003	78	1	0	0	0	50	0	0	0	50	141
EC0004	82	1	0	0	0	20	0	0	0	20	152
EC0005	75	1	0	0	0	0.5	0	0	25	25.5	150
EC0006	181	4	16	40.5	0	5	5.5	0	0	67	86
EC0007	184	5	36	63.5	70	37	5	0	0.5	212	5
EC0008	188	4	0	82.5	70	60	15	0	0	227.5	10
EC0009	192	4	25	76.5	70	60	0.5	0.5	0	232.5	9
EC0010	193	1	0	0	60	0	0	0	0	60	136
EC0011	197	4	0.5	32.5	30	75	25	0	0	163	21
EC0012	198	6	21	32	15	50	5	3	0	126	17
EC0013	199	3	60.5	16.5	1	30.5	0	0	0	108.5	64
EC0014	180	6	55	66	30	40	10	15	0	216	2
EC0015	291	4	0.5	70.5	60.5	15	5	0	0	151.5	26
EC0016	297	1	0.5	1	0.5	40.5	0.5	0	0	43	144
EC0017	301	4	16.5	23.5	40	40	0	0	0.5	120.5	43
EC0018	308	6	31	6	0.5	23	25	3.5	3	92	34
EC0019	364	6	0	29.5	20	48	35	3	3	138.5	13
EC0020	365	4	0	42	0	60	10	0	3	115	48
EC0021	375	5	26	126.5	60	80	6	0.5	0	299	1
EC0022	462	5	35	20	20.5	20.5	2	0	0	98	40
EC0023	571	5	40	30	0	20	20	5	0.5	115.5	28
EC0024	642	2	0	0.5	0	35	0	5	1	41.5	132
EC0025	648	3	0	0	10	25	15	0	0.5	50.5	110
EC0026	649	2	0	0.5	0	20	5.5	0	0.5	26.5	137
EC0027	650	2	0	0	1	10	5	0	0.5	16.5	147
EC0028	651	4	0	5.5	25	20	15.5	0	0	66	87
EC0029	652	2	0	0	0	10	33	0	0	43	131
EC0030	696	5	30.5	90.5	20	30	20.5	0	0	191.5	7
EC0031	700	4	20.5	55.5	0	70	0.5	5	0.5	152	25
EC0032	672	6	16.5	57	10	10.5	45	35	1	175	6
EC0033	673	6	18	27.5	15	60	15	3	0.5	139	12
EC0034	678	4	30.5	52	31.5	30	0	0	0	144	29
EC0035	674	3	10	30.5	0	30	0.5	0	0	71	96
EC0036	711	4	3	80.5	0	30	3	0.5	0	117	44
EC0037	713	3	0	77	40	30	1	0	0	148	52
EC0038	1116	4	0	20.5	41.5	60.5	5	0.5	0	128	39
EC0039	1120	2	0.5	0	15.5	50	1	0	0	67	116
EC0040	1287	4	0	0.5	0	20	20	30	3	73.5	75
EC0041	1303	5	50	60.5	10	40.5	25.5	1	1	188.5	8
EC0042	1310	4	0.5	2.5	0	10	5	60	0	78	66
EC0043	1288	4	3.5	76	0	70.5	5.5	0	0	155.5	23
EC0044	1292	4	0	57	5	10	5	0	0	77	68

Table 2. Continued.

PLOT#	Riparian Mapping Polygon#	Structural Layers with >1% cover	Low Shrub Cover (%)	Medium Shrub Cover (%)	Tall Shrub Cover (%)	Tall Tree Cover (%)	Pole Tree Cover (%)	Small Tree Cover (%)	Sapling Tree Cover (%)	Total Woody Cover (%)	Structural Diversity Rank
EC0045	1294	3	0	27	20	50	0.5	0	0	97.5	76
EC0046	1412	4	0	81	20.5	60	0	3	0	164.5	20
EC0047	1414	2	0	40.5	0	30	0	0	0	70.5	115
EC0048	1415	2	0	0	12	0	0	0	6	18	145
EC0049	1420	4	0	61.5	0	40	10	5.5	0	117	45
EC0050	1441	4	0	63.5	10	60	0	6	0	139.5	33
EC0051	1444	2	0	10	0	40	0	0.5	0	50.5	128
EC0052	1445	4	5.5	27	0	25	10.5	0	0	68	84
EC0053	1449	2	0	15.5	0	10	0	0.5	0	26	138
EC0054	1593	2	0	77	0	20	0	0	0.5	97.5	101
EC0055	1595	2	0	35.5	0	30	0	0	0	65.5	119
EC0056	1596	2	0.5	56	1	20	0.5	0	0	78	108
EC0057	1604	6	0	32.5	21	51	16	5.5	10	136	14
EC0058	1681	2	0	0.5	0.5	5	10	0.5	0.5	17	146
EC0059	1682	3	0	30	15	15	0.5	0	0	60.5	104
EC0060	1687	3	0	5.5	5	60	0	0	0.5	71	95
EC0061	1688	1	0	0.5	0	50	0	0	0	50.5	140
EC0062	1712	2	0	2.5	0.5	70	0	0	0	73	112
EC0063	1890	3	0	21	30.5	40.5	0.5	0.5	1	94	81
EC0064	1892	4	5	26	30	50.5	0.5	0.5	0.5	113	50
EC0065	1920	2	0.5	0.5	0	0.5	70.5	10.5	1	83.5	107
EC0066	1924	3	1	1.5	0	40	5.5	0	0	48	113
EC0067	1927	5	40	2	0	10.5	0.5	10	5	68	63
EC0068	1941	1	0	0.5	0.5	50	0.5	0	0	51.5	139
EC0069	1950	3	0	0.5	0	0.5	20.5	5.5	10	37	125
EC0070	1947	2	0.5	0	0	0	60	30	0.5	91	103
EC0071	1953	6	20.5	5	0	10	40.5	5	5	86	38
EC0072	1967	4	0	31.5	20.5	30	50	0	0.5	132.5	36
EC0073	1957	3	0	50.5	10.5	40	0	0	0.5	101.5	70
EC0074	1960	2	0	60	0.5	15	0	0.5	0	76	109
EC0075	1997	3	0	21.5	5.5	40	0	0	0.5	67.5	100
EC0076	1998	3	0	1.5	5	75	0	0	0.5	82	91
EC0077	1999	2	0	5.5	0.5	60	0	0	0	66	118
EC0078	2000	2	0	26	1	25	0.5	0	0.5	53	126
EC0079	2001	2	0.5	41	0.5	30	0	0	0	72	114
EC0080	2051	4	0	50.5	30.5	30	5	0	0	116	46
EC0081	2151	3	0	20	10	40	0	0.5	0	70.5	98
EC0082	2201	2	0	0.5	0	10	20	0	0	30.5	135
EC0083	2202	2	0	50	0	40	0	0	0	90	105
EC0084	2203	2	0	30.5	0	20	0.5	0	0	51	127
EC0085	2204	2	0	35	0	15	0	0	0	50	129
EC0086	2209	1	0	21	0	0.5	1	0	0	22.5	151
EC0087	2207	2	0	0.5	0	10	5	0	0	15.5	148
EC0088	2208	2	0	0.5	0	40	5.5	0	0	46	130
EC0089	2328	2	0	1	10.5	50.5	0.5	0	0	62.5	120

Table 2. Continued.

PLOT#	Riparian Mapping Polygon#	Structural Layers with >1% cover	Low Shrub Cover (%)	Medium Shrub Cover (%)	Tall Shrub Cover (%)	Tall Tree Cover (%)	Pole Tree Cover (%)	Small Tree Cover (%)	Sapling Tree Cover (%)	Total Woody Cover (%)	Structural Diversity Rank
EC0091	2340	2	1	0	0.5	15	45	0	0	61.5	123
EC0092	2313	3	20.5	6	0	50	1	0	0.5	78	93
EC0093	2321	1	0.5	1	0	25	0	0.5	0.5	27.5	149
EC0094	2323	1	0	0.5	0	45	0.5	0.5	0	46.5	143
EC0095	2327	3	0	71.5	25	50	0	0	0.5	147	53
EC0096	2346	3	0	61	15	10	0	0	0.5	86.5	88
EC0097	2350	3	0	26	60.5	65	0.5	0	0.5	152.5	49
EC0098	2352	3	0	61	20.5	15	0	0	0	96.5	77
EC0099	2354	3	0	71.5	20	10	0	0	0.5	102	69
EC0100	2366	5	0	5.5	25	20	10.5	0.5	15.5	77	60
EC0101	2371	4	0	2	5.5	50	10.5	0	1	69	83
EC0102	2397	2	0	0.5	0	50	10	0	0.5	61	124
EC0103	2398	3	0	5.5	0	60	5.5	0	0	71	97
EC0104	2401	5	0	90.5	10.5	10	61	0	5	177	11
EC0105	2483	6	10	5	5	5	70.5	6	1	102.5	24
EC0106	2465	5	5.5	72.5	5.5	40	30.5	0	0	154	16
EC0107	2472	4	0	61.5	20	5	20.5	0	0.5	107.5	55
EC0108	2477	4	0	60	5.5	3	11	0	0	79.5	65
EC0109	2492	4	5.5	70	0.5	20	45	0.5	0	141.5	31
EC0110	2510	3	0	50	10	40	0	0	0	100	73
EC0111	2512	3	0	41	40.5	60	0	0	0	141.5	58
EC0112	2514	3	0	17	5.5	70	0	0	0	92.5	82
EC0113	2517	4	10	20.5	20.5	50	0	0.5	0	101.5	59
EC0114	2518	3	0	56	20	20	0	0	0	96	78
KC0001	1920	2	0	0	0	0	63	3.5	0	66.5	117
KC0002	1924	2	0	1	1.5	60	0	0	0	62.5	121
KC0003	1916	3	0	0	20.5	70	10	0	0	100.5	72
KC0004	1953	4	0	0	10	70	20	13	0	113	51
KC0005	1964	2	0	0	24.5	70	0	0	0	94.5	102
KC0006	2051	3	0	80	2	60	0	0	0	142	57
KC0007	2150	3	0	3.5	4	60	0	0	0	67.5	99
KC0008	2183	2	0.5	31	1	30	0	0	0	62.5	122
KC0009	2184	6	17	30.5	0	60	10	60	10	187.5	4
KC0010	2208	2	0	0	0	70	4	0	0	74	111
KC0011	2240	2	0	1	17	70	0	0	0	88	106
KC0012	2315	1	0	0	0.5	63	0	0	0	63.5	134
KC0013	2304	3	0	91	0	60	3	0	0	154	47
KC0014	2350	3	0	0	40.5	50	10	0	0	100.5	71
KC0015	2370	4	0	0	1.1	80	10	3	0	94.1	61
KC0016	2392	4	0.5	50	0	73	0	3	4	130.5	37
KC0017	2415	2	0	1	40	70	0	0	0	111	94
KC0018	2419	3	0	4	17	63	0	0	0	84	90
KC0019	2426	3	10	72	0	80	0	0	0.5	162.5	41
KC0020	2482	5	10	0	4.5	0	80	17	3	114.5	30
KC0021	2464	3	10	110	0	90	0	0	0	210	22

Table 2. Continued.

PLOT#	Riparian Mapping Polygon#	Structural Layers with >1% cover	Low Shrub Cover (%)	Medium Shrub Cover (%)	Tall Shrub Cover (%)	Tall Tree Cover (%)	Pole Tree Cover (%)	Small Tree Cover (%)	Sapling Tree Cover (%)	Total Woody Cover (%)	Structural Diversity Rank
KC0022	2513	3	0	1.6	80	80	0	0	0	161.6	42
KC0023	2576	4	17	0	70	50	3	0	1	141	32
KC0024	2563	3	0	4	40	100	0	0	1	145	54
KC0025	2614	6	23	1.5	10	30	20	13	0.5	98	27
KC0026	2638	5	30	0.5	3.5	60	30.5	13	0	137.5	18
KC0027	2667	6	20	4.5	3	0.5	30.5	50	3	111.5	19
KC0028	2714	3	0	0.5	3.5	60	20	0	0	84	89
SC0001	690	0	0	0.5	0	0	0	0	0	0.5	154
SC0002	391	4	1	30	3	31.5	5	0.5	0.5	71.5	79
SC0003	692	3	13	83	0	20.5	0.5	0	0	117	62
SC0004	698	4	53	23	2	60	0	0	0	138	35
SC0005	665	7	40	55.5	10	30	33	10	3.5	182	3
SC0006	668	4	1	3	0	60	0	3	10	77	67
SC0007	670	4	0	0	28	25	10.5	10	1	74.5	74
SC0008	707	3	3.5	56.5	0	30	0	0	0	90	85
SC0009	708	5	20	83	3	30	20	0	0	156	15
SC0010	710	3	21	80	0	40	1	0	1	143	56
SC0011	1112	3	0	0	3	20	0	0	3.5	26.5	133
SC0012	1118	3	0	2.5	22	70	0	0	0	94.5	80

Table 3. Species richness, exotic/species richness rank, and rank combining exotic/species richness and structural diversity ranks. Exotic/species richness rank is calculated by dividing total native species richness by the relative herbaceous exotic coverage value. Combination rank includes exotic/species richness and structuraal diversity rankings.

PLOT#	Riparian Mapping Polygon#	Exotic Woody Species# (Russian Olive)	Native Woody Species#	Total Woody Species#	Exotic Herb Species#	Native Herb Species#	Total Herb Species#	Total Native Species#	Total Species#	Relative Exotic Herb Cover	Exotic/Species Richness Rank	Combination Rank
EC0001	60	0	5	5	5	1	6	6	11	1.00	129	120
EC0002	77	0	2	2	7	4	11	6	13	0.93	119	145
EC0003	78	0	1	1	3	3	6	4	7	0.99	142	149
EC0004	82	0	1	1	4	0	4	1	5	1.00	154	154
EC0005	75	0	1	1	4	2	6	3	7	0.98	151	153
EC0006	181	0	9	9	7	3	10	12	19	0.94	67	75
EC0007	184	0	14	14	6	2	8	16	22	0.99	45	20
EC0008	188	0	8	8	4	4	8	12	16	0.61	37	19
EC0009	192	0	9	9	4	4	8	13	17	0.48	21	3
EC0010	193	0	9	9	3	2	5	11	14	0.50	29	85
EC0011	197	0	10	10	8	8	16	18	26	0.63	17	9
EC0012	198	0	9	9	5	2	7	11	16	0.99	81	38
EC0013	199	0	11	11	8	2	10	13	21	0.99	64	55
EC0014	180	0	10	10	7	6	13	16	23	0.89	41	14
EC0015	291	0	5	5	8	6	14	11	19	0.98	78	42
EC0016	297	0	7	7	3	2	5	9	12	0.94	93	126
EC0017	301	0	10	10	5	4	9	14	19	0.31	8	22
EC0018	308	0	9	9	9	4	13	13	22	0.66	35	29
EC0019	364	0	9	9	7	4	11	13	20	0.89	56	28
EC0020	365	0	7	7	11	3	14	10	21	0.99	91	66
EC0021	375	0	12	12	6	4	10	16	22	0.95	42	13
EC0022	462	0	9	9	5	8	13	17	22	0.76	27	27
EC0023	571	0	5	5	7	4	11	9	16	0.60	54	35
EC0024	642	0	6	6	6	3	9	9	15	0.94	94	123
EC0025	648	0	2	2	4	2	6	4	8	0.99	145	133
EC0026	649	0	3	3	3	2	5	5	8	0.95	132	142
EC0027	650	0	4	4	2	1	3	5	7	0.15	10	81
EC0028	651	0	6	6	3	1	4	7	10	1.00	117	111
EC0029	652	0	2	2	3	1	4	3	6	0.92	148	147
EC0030	696	0	11	11	4	5	9	16	20	0.89	39	17
EC0031	700	0	10	10	4	6	10	16	20	0.49	13	10
EC0032	672	0	10	10	6	4	10	14	20	0.87	46	23
EC0033	673	0	12	12	6	4	10	16	22	0.52	15	2
EC0034	678	0	8	8	4	2	6	10	14	0.95	86	46
EC0035	674	0	6	6	2	2	4	8	10	0.67	70	86
EC0036	711	0	6	6	6	1	7	7	13	0.99	113	80
EC0037	713	0	10	10	2	3	5	13	15	0.88	55	44
EC0038	1116	0	8	8	6	8	14	16	22	0.77	30	30
EC0039	1120	0	6	6	8	10	18	16	24	0.13	4	50
EC0040	1287	1	2	3	5	9	14	11	17	0.72	53	56
EC0041	1303	0	7	7	5	9	14	16	21	0.34	6	1
EC0042	1310	1	6	7	9	8	17	14	24	0.85	44	45
EC0043	1288	0	12	12	9	5	14	17	26	0.68	22	16
EC0044	1292	0	9	9	8	13	21	22	30	0.08	1	31
EC0045	1294	0	8	8	2	6	8	14	16	0.07	2	34

Table 3. Continued.

PLOT#	Riparian Mapping Polygon#	Exotic Woody Species# (Russian Olive)	Native Woody Species#	Total Woody Species#	Exotic Herb Species#	Native Herb Species#	Total Herb Species#	Total Native Species#	Total Species#	Relative Exotic Herb Cover	Exotic/Species Richness Rank	Combination Rank
EC0046	1412	0	8	8	4	3	7	11	15	0.38	18	8
EC0047	1414	0	4	4	6	3	9	7	13	0.74	95	113
EC0048	1415	0	4	4	2	6	8	10	12	0.06	3	71
EC0049	1420	1	8	9	6	4	10	12	19	0.35	9	24
EC0050	1441	1	12	13	6	6	12	18	25	0.81	28	26
EC0051	1444	0	4	4	4	2	6	6	10	0.78	110	127
EC0052	1445	0	10	10	5	3	8	13	18	0.91	57	68
EC0053	1449	1	3	4	3	3	6	6	10	0.67	100	128
EC0054	1593	0	8	8	7	8	15	16	23	0.81	34	62
EC0055	1595	0	4	4	5	0	5	4	9	1.00	147	141
EC0056	1596	0	6	6	6	3	9	9	15	0.79	75	98
EC0057	1604	0	12	12	11	10	21	22	33	0.90	24	6
EC0058	1681	1	3	4	8	8	16	11	20	0.90	69	117
EC0059	1682	0	4	4	3	3	6	7	10	0.36	38	69
EC0060	1687	0	4	4	9	3	12	7	16	0.84	104	108
EC0061	1688	0	2	2	4	1	5	3	7	0.94	149	152
EC0062	1712	0	6	6	9	10	19	16	25	0.57	19	60
EC0063	1890	1	7	8	4	6	10	13	18	0.82	48	58
EC0064	1892	1	7	8	7	4	11	11	19	0.98	79	57
EC0065	1920	1	5	6	6	6	12	11	18	0.98	80	101
EC0066	1924	0	7	7	4	5	9	12	16	0.98	68	97
EC0067	1927	0	7	7	4	3	7	10	14	0.96	88	74
EC0068	1941	0	4	4	5	4	9	8	13	0.60	62	109
EC0069	1950	1	3	4	6	1	7	4	11	1.00	146	144
EC0070	1947	0	2	2	4	1	5	3	7	0.98	152	132
EC0071	1953	1	9	10	7	3	10	12	20	0.91	63	40
EC0072	1967	0	7	7	2	2	4	9	11	0.57	47	36
EC0073	1957	0	5	5	1	5	6	10	11	0.65	51	52
EC0074	1960	0	5	5	4	2	6	7	11	0.45	52	84
EC0075	1997	0	7	7	8	8	16	15	23	0.97	50	72
EC0076	1998	0	5	5	6	3	9	8	14	0.71	76	87
EC0077	1999	0	3	3	5	2	7	5	10	0.96	133	130
EC0078	2000	1	7	8	7	5	12	12	20	0.92	65	104
EC0079	2001	0	7	7	5	4	9	11	16	0.61	40	77
EC0080	2051	0	4	4	4	3	7	7	11	0.97	112	82
EC0081	2151	0	4	4	4	2	6	6	10	0.99	125	121
EC0082	2201	0	2	2	4	1	5	3	7	0.99	153	151
EC0083	2202	0	2	2	2	2	4	4	6	0.12	11	48
EC0084	2203	0	2	2	7	4	11	6	13	0.44	61	103
EC0085	2204	0	2	2	4	4	8	6	10	0.27	26	78
EC0086	2209	0	4	4	7	4	11	8	15	0.94	103	131
EC0087	2207	0	2	2	8	3	11	5	13	0.91	131	148
EC0088	2208	0	3	3	6	1	7	4	10	0.95	140	143
EC0089	2328	0	5	5	2	0	2	5	7	1.00	135	134
EC0090	2338	0	6	6	5	1	6	7	12	1.00	116	138
EC0091	2340	0	4	4	2	1	3	5	7	1.00	134	136
EC0092	2313	0	6	6	5	3	8	9	14	0.99	99	105

Table 3. Continued.

PLOT#	Riparian Mapping Polygon#	Exotic Woody Species# (Russian Olive)	Native Woody Species#	Total Woody Species#	Exotic Herb Species#	Native Herb Species#	Total Herb Species#	Total Native Species#	Total Species#	Relative Exotic Herb Cover	Exotic/Species Richness Rank	Combination Rank
EC0093	2321	0	4	4	5	4	9	8	13	0.98	107	135
EC0094	2323	0	2	2	3	2	5	4	7	0.99	144	150
EC0095	2327	0	7	7	4	2	6	9	13	0.98	98	73
EC0096	2346	0	6	6	2	3	5	9	11	0.44	32	49
EC0097	2350	0	8	8	4	1	5	9	13	0.88	89	64
EC0098	2352	0	5	5	4	0	4	5	9	1.00	138	116
EC0099	2354	0	6	6	3	1	4	7	10	0.85	105	94
EC0100	2366	0	6	6	3	5	8	11	14	0.97	77	63
EC0101	2371	0	6	6	6	5	11	11	17	0.93	71	76
EC0102	2397	0	2	2	3	2	5	4	7	0.95	139	140
EC0103	2398	0	3	3	6	3	9	6	12	0.12	5	41
EC0104	2401	0	7	7	2	4	6	11	13	0.85	66	33
EC0105	2483	0	6	6	3	3	6	9	12	0.98	97	51
EC0106	2465	0	11	11	4	0	4	11	15	1.00	84	39
EC0107	2472	0	7	7	3	5	8	12	15	0.88	60	47
EC0108	2477	0	7	7	2	3	5	10	12	0.72	58	54
EC0109	2492	0	7	7	5	1	6	8	13	0.99	109	67
EC0110	2510	0	5	5	3	0	3	5	8	1.00	137	112
EC0111	2512	0	5	5	6	1	7	6	12	0.99	128	100
EC0112	2514	0	6	6	3	0	3	6	9	1.00	130	115
EC0113	2517	0	7	7	4	2	6	9	13	0.46	36	37
EC0114	2518	0	5	5	3	1	4	6	9	0.73	106	99
KC0001	1920	0	1	1	4	3	7	4	8	0.95	141	137
KC0002	1924	0	6	6	4	4	8	10	14	0.98	90	114
KC0003	1916	0	4	4	3	5	8	9	12	0.78	72	70
KC0004	1953	0	3	3	5	3	8	6	11	0.94	120	91
KC0005	1964	0	5	5	3	3	6	8	11	0.92	101	110
KC0006	2051	0	3	3	3	3	6	6	9	0.85	114	92
KC0007	2150	0	4	4	1	2	3	6	7	0.99	124	122
KC0008	2183	0	6	6	2	2	4	8	10	0.85	96	118
KC0009	2184	0	5	5	3	6	9	11	14	0.53	31	4
KC0010	2208	0	1	1	6	2	8	3	9	0.98	150	139
KC0011	2240	0	3	3	4	3	7	6	10	0.98	122	124
KC0012	2315	0	2	2	2	2	4	4	6	0.99	143	146
KC0013	2304	0	5	5	2	1	3	6	8	0.99	123	90
KC0014	2350	0	3	3	2	3	5	6	8	0.99	127	107
KC0015	2370	0	3	3	3	5	8	8	11	0.99	108	89
KC0016	2392	0	5	5	3	8	11	13	16	0.28	7	15
KC0017	2415	0	4	4	2	2	4	6	8	0.99	126	119
KC0018	2419	0	4	4	3	6	9	10	13	0.91	83	93
KC0019	2426	0	6	6	5	1	6	7	12	1.00	118	83
KC0020	2482	0	5	5	2	4	6	9	11	0.92	92	53
KC0021	2464	0	4	4	4	3	7	7	11	0.44	49	32
KC0022	2513	0	5	5	2	0	2	5	7	1.00	136	96
KC0023	2576	0	5	5	4	7	11	12	16	0.37	14	18
KC0024	2563	0	5	5	10	2	12	7	17	0.99	115	88
KC0025	2614	0	8	8	3	4	7	12	15	0.36	12	12

Table 3. Continued.

PLOT#	Riparian Mapping Polygon#	Exotic Woody Species# (Russian Olive)	Native Woody Species#	Total Woody Species#	Exotic Herb Species#	Native Herb Species#	Total Herb Species#	Total Native Species#	Total Species#	Relative Exotic Herb Cover	Exotic/Species Richness Rank	Combination Rank
KC0026	2638	0	6	6	3	5	8	11	14	0.66	43	25
KC0027	2667	0	7	7	6	5	11	12	18	0.43	20	11
KC0028	2714	0	4	4	4	6	10	10	14	0.92	85	95
SC0001	690	0	1	1	6	7	13	8	14	0.76	87	129
SC0002	391	1	7	8	2	5	7	12	15	0.87	59	65
SC0003	692	0	6	6	1	5	6	11	12	0.95	73	61
SC0004	698	0	9	9	2	2	4	11	13	0.36	16	21
SC0005	665	1	9	10	3	4	7	13	17	0.64	33	5
SC0006	668	0	4	4	2	2	4	6	8	0.96	121	102
SC0007	670	0	7	7	3	3	6	10	13	0.90	82	79
SC0008	707	0	6	6	4	1	5	7	11	0.94	111	106
SC0009	708	0	8	8	2	2	4	10	12	0.40	23	7
SC0010	710	0	8	8	4	3	7	11	15	0.96	74	59
SC0011	1112	1	2	3	7	6	13	8	16	0.92	102	125
SC0012	1118	0	5	5	3	8	11	13	16	0.57	25	43

Table 4. Bats captured during 2003-2004 surveys in the Wild and Scenic Missouri River corridor, Montana.

Site[1]	Date	Species[2]	Sex[3]	Age[4]	Forearm (mm)	Reproductive Status[5]
1	6-Aug-03	MYCI	F	A	31.7	L
1	6-Aug-03	MYLU	M	A	37.2	U
1	6-Aug-03	MYCI	F	J	30.1	N
1	6-Aug-03	MYLU	M	A	38.1	U
1	6-Aug-03	MYLU	F	A	36.8	U
1	6-Aug-03	MYLU	F	A	36.6	N
1	6-Aug-03	MYLU	F	A	36.5	N
1	6-Aug-03	MYLU	M	A	37.6	U
1	6-Aug-03	MYLU	F	A	38.2	U
1	6-Aug-03	MYEV	F	A	39.3	P
1	6-Aug-03	MYCI	M	A	32.3	U
1	6-Aug-03	MYLU	M	A	38.3	N
1	6-Aug-03	MYLU	M	A	36.5	U
1	6-Aug-03	MYEV	F	A	42.5	U
1	6-Aug-03	MYLU	M	J	34.3	N
1	6-Aug-03	MYLU	F	A	38.1	U
1	6-Aug-03	MYLU	M	A	36.5	N
1	6-Aug-03	MYEV	M	A	42.2	N
1	6-Aug-03	MYLU	F	J	38.8	N
1	6-Aug-03	MYEV	F	A	40.5	P
1	6-Aug-03	MYCI	F	J	30.4	N
1	6-Aug-03	MYEV	M	J	38.5	N
1	6-Aug-03	MYLU	F	J	37.3	N
1	6-Aug-03	MYCI	F	J	32.7	N
1	6-Aug-03	MYLU	F	J	38.4	N
1	6-Aug-03	MYLU	M	J	35.2	N
2	7-Aug-03	COTO	F	A	44.2	N
2	7-Aug-03	MYEV	F	A	38.3	P
2	7-Aug-03	MYEV	F	A	40.1	P
2	7-Aug-03	MYEV	F	A	39.8	P
2	7-Aug-03	MYEV	M	A	39.4	S
2	7-Aug-03	MYEV	F	A	38.2	P
2	7-Aug-03	COTO	F	A	41.4	N
3	9-Aug-03	MYLU	U	U	U	U
4	10-Aug-03	MYEV	F	A	U	N
5	12-Jul-04	MYEV	M	A	37.9	N
5	12-Jul-04	MYLU	M	A	34.8	N
6	14-Jul-04	MYLU	F	A	36.5	N
6	14-Jul-04	EPFU	F	A	46.1	R
6	14-Jul-04	MYCI	M	A	31.3	N

Table 4. Continued.

Site[1]	Date	Species[2]	Sex[3]	Age[4]	Forearm (mm)	Reproductive Status[5]
7	15-Jul-04	MYLU	F	A	36.8	R
8	16-Jul-04	MYEV	M	A	39.3	N
8	16-Jul-04	MYLU	M	A	37.2	N

[1] (1) opposite Dark Butte: T23NR14E, Sec. 9NENE, (2) mile 80.5: T22NR15E, Sec. 2SWNW, (3) mile 120.5: T23NR21E, Sec. 5SENE, (4) mile 129.5: T23NR22E, Sec. 17 center, (5) Little Sandy Creek: T26NR12E, Sec. 12NWNE, (6) below Steamboat Rock, T23NR14E, Sec. 4NWNW, (7) Arrow Creek: T23NR15E, Sec. 32SESW (8) mile 81.5: T22NR15E, Sec. 2NESE.

[2] COTO (Townsend's Big-eared Bat: *Corynorhinus townsendii*), EPFU (Big Brown Bat: *Eptesicus fuscus*), MYCI (Western Small-footed Myotis: *Myotis ciliolabrum*), MYEV (Long-eared Myotis: *Myotis evotis*), MYLU (Little Brown Myotis: *Myotis lucifugus*).

[3] M = male, F = female, U = unknown.

[4] A = adult, J = juvenile, U = unknown.

[5] Males: N = non-scrotal, S = scrotal, U = undetermined; Females: N = non-lactating, R = pregnant, L = lactating, P = post-lactating, U = undetermined.

Table 5. Mussel species documented. CPUE is the catch per unit effort for amount of time searched.

Watercourse	Latitude	Longitude	Collection date	Search_area (m2)	Mussel Species	#_live	#_recent dead	CPUE (mussels/man-hr)
Missouri River	47.91539	-110.05818	7/14/04	200	*Lampsilis siliquoidaea*	1	3	0.7
Missouri River	47.91539	-110.05818	7/14/04	200	*Ligumia recta*	0	4	0.0
Eagle Creek	47.91539	-110.05818	7/14/04	150	*Ligumia recta*	0	0	0.0
Eagle Creek	47.91539	-110.05818	7/14/04	150	*Lampsilis siliquoidaea*	0	0	0.0
Missouri River	47.92963	-110.06351	7/14/04	150	*Lampsilis siliquoidaea*	2	14	4.0
Missouri River	47.92963	-110.06351	7/14/04	150	*Ligumia recta*	1	18	2.0
Missouri River	48.0332	110.2241	7/12/04	150	*Lampsilis siliquoidaea*	2	4	4.0
Missouri River	48.0332	110.2241	7/12/04	150	*Ligumia recta*	0	5	0.0
Missouri River	48.03286	-110.14708	7/12/04	1000	*Lampsilis siliquoidaea*	2	4	2.0
Missouri River	48.03286	-110.14708	7/12/04	1000	*Ligumia recta*	1	2	1.0
Missouri River	48.03286	-110.14708	7/12/04	1000	*Pyganodon grandis*	1	0	1.0
Missouri River	48.03129	-110.13382	7/12/04	500	*Lampsilis siliquoidaea*	5	20	6.7
Missouri River	48.03129	-110.13382	7/12/04	500	*Ligumia recta*	1	15	1.3
Missouri River	48.02891	-110.13623	7/12/04	100	*Ligumia recta*	0	2	0.0
Missouri River	48.02891	-110.13623	7/12/04	100	*Lampsilis siliquoidaea*	24	4	32.0
Missouri River	47.94737	-110.07987	7/13/04	100	*Lampsilis siliquoidaea*	0	1	0.0
Missouri River	47.94737	-110.07987	7/13/04	100	*Ligumia recta*	2	1	2.0
Missouri River	47.81932	-110.05019	7/14/04	100	*Lampsilis siliquoidaea*	6	3	8.0
Missouri River	47.81932	-110.05019	7/14/04	100	*Ligumia recta*	0	1	0.0
Missouri River	47.78313	-109.95358	7/14/04	300	*Lampsilis siliquoidaea*	38	3	50.7
Missouri River	47.78313	-109.95358	7/14/04	300	*Ligumia recta*	2	5	2.7
Missouri River	47.78313	-109.95358	7/14/04	300	*Pyganodon grandis*	1	1	1.3
Missouri River	47.76206	-109.91104	7/15/04	150	*Lampsilis siliquoidaea*	0	5	0.0
Missouri River	47.76206	-109.91104	7/15/04	150	*Ligumia recta*	0	4	0.0
Missouri River	47.76273	-109.89425	7/15/04	150	*Lampsilis siliquoidaea*	0	7	0.0
Missouri River	47.76273	-109.89425	7/15/04	150	*Ligumia recta*	0	2	0.0
Missouri River	47.73767	-109.87557	7/15/04	150	*Lampsilis siliquoidaea*	0	7	0.0
Missouri River	47.73767	-109.87557	7/15/04	150	*Ligumia recta*	0	2	0.0
Missouri River	47.71517	-109.8367	7/15/04	200	*Lampsilis siliquoidaea*	0	5	0.0
Missouri River	47.71517	-109.8367	7/15/04	200	*Ligumia recta*	0	1	0.0
Missouri River	47.70414	-109.75473	7/16/04	200	*Lampsilis siliquoidaea*	11	1	11.0
Missouri River	47.70414	-109.75473	7/16/04	200	*Ligumia recta*	3	1	3.0
Missouri River	47.73372	-109.679	7/17/04	200	*Lampsilis siliquoidaea*	1	10	2.0
Missouri River	47.73372	-109.679	7/17/04	200	*Ligumia recta*	1	4	2.0
Arrow Creek	47.71516	-109.8336	7/16/04	200	*Lampsilis siliquoidaea*	0	2	0.0
Arrow Creek	47.71516	-109.8336	7/16/04	200	*Ligumia recta*	0	1	0.0

Table 6. Browse growth form summary for species occurring in >10 plots.

Species	**Buffaloberry (*Shepherdia Argentea*)**	**Golden currant (*Ribes aureum*)**	**Wood's rose (*Rosa woodsii*)**	**Narrowleaf willow (*Salix exigua*)**	**Snowberry (*Symphoricarpos occidentalis*)**	**Gooseberry (*Ribes setosum*)**	**Yellow willow (*Salix lutea*)**	**Skunkbush sumac (*Rhus trilobata*)**	**Redosier dogwood (*Cornus sericea*)**	**Chokecherry (*Prunus virginiana*)**	**Average per Growth Form Type**
#plots	10	32	74	10	89	45	30	35	20	29	
%olderU*	100	100	94.1	87.5	86.2	62.5	92.9	80	75	70	84.8
%olderRL*	0	0	0	0	0	0	0	10	0	10	10.0
%olderRT*	10	0	5.9	12.5	0	0	7.1	0	25	10	11.8
%olderA*	0	0	0	0	13.8	37.5	0	10	0	10	17.8
%matureU	90	76.7	87	83.3	79.5	78	78.9	77.4	67	73	79.1
%matureRL	0	0	0	0	0	0	5.3	3.2	0	11.5	6.7
%matureRT	0	20	5.8	16.7	6.8	4.9	15.8	9.7	28	15.4	13.7
%matureA	0	3.3	5.8	0	13.6	17.1	0	9.7	5	0	9.1
%youngU	100	100	92	100	88	100	50	53.3	40	31.6	75.5
%youngRL	0	0	0	0	0	0	0	0	0	0	0.0
%youngRT	0	0	0	0	0	0	50	6.7	40	15.8	28.1
%youngA	0	0	8	0	12	0	0	40	20	31.6	22.3
AverageU	96.7	92.2	91.0	90.3	84.6	80.2	73.9	70.2	60.7	58.2	
AverageRL	0.0	0.0	0.0	0.0	0.0	0.0	1.8	4.4	0.0	7.2	
AverageRT	3.3	6.7	3.9	9.7	2.3	1.6	24.3	5.5	31.0	13.7	
AverageA	0.0	1.1	4.6	0.0	13.1	18.2	0.0	19.9	8.3	13.9	

* Key to browse growth form abbreviations (Keigley and Frasina 1998)

U	Uninterrupted-growth-type. Light to moderate browsing while terminal bud is vulnerable
RL	Released-type. Produced by a change from intense browsing to light-to-moderate browsing
RT	Retrogressed-type. Produced by a change from light-to-moderate browsing to intense browsing
A	Arrested-type. Produced when a young plant has intense browsing throughout its life

Table 7. All plant species documented on plots.

Common name	Scientific Name	Occurences in 154 plots
Alfalfa	*Medicago sativa* L.	2
Alkali cordgrass	*Spartina gracilis* Trin.	3
Alkali saltgrass	*Distichlis stricta* (Torr.) Rydb.	1
Amaranth; pigweed	*Amaranthus* spp. L.	2
American bulrush	*Scirpus americanus* Pers.	2
American licorice	*Glycyrrhiza lepidota* Pursh	56
American vetch	*Vicia americana* Muhl.	10
Asparagus	*Asparagus officinalis* L.	4
Basin wildrye	*Elymus cinereus* Scribn. & Merr.	2
Basin wildrye	*Leymus cinereus* (Scribn. & Merr.) A. Love	12
Beadruby	*Maianthemum dilatatum* (Wood) Nels. & Macbr.	7
Beaked sedge	*Carex utriculata* Boott	1
Bearded wheatgrass	*Agropyron caninum* (L.) Beauv.	2
Bentgrass	*Agrostis* spp. L.	2
Bigleaf sandwort	*Moehringia macrophylla* (Hook.) Fenzl	1
Black greasewood	*Sarcobatus vermiculatus* (Hook.) Torr.	1
Black snake-root	*Sanicula marilandica* L.	1
Blue wildrye	*Elymus glaucus* Buckl.	7
Bluebunch wheatgrass	*Pseudoroegneria spicata* (Pursh) A. Love	1
Bottle-brush squirrel-tail	*Elymus elymoides* (Raf.) Swezey	1
Box-elder	*Acer negundo* L.	36
California hesperochiron	*Hesperochiron californicus* (Benth.) S. Wats.	4
Canada bluegrass	*Poa compressa* L.	2
Canada goldenrod	*Solidago canadensis* L.	1
Canada thistle	*Cirsium arvense* (L.) Scop.	59
Canada wildrye	*Elymus canadensis* L.	11
Cheatgrass	*Bromus tectorum* L.	12
Clasping pepper-grass	*Lepidium perfoliatum* L.	2
Clover	*Trifolium* spp. L.	2
Coast-blite goosefoot	*Chenopodium rubrum* L.	2
Columbia clematis	*Clematis columbiana* (Nutt.) T. & G.	4
Common burdock	*Arctium minus* (Hill) Bernh.	7
Common chokecherry	*Prunus virginiana* L.	30
Common dandelion	*Taraxacum officinale* Weber	1
Common hound's-tongue	*Cynoglossum officinale* L.	20
Common juniper	*Juniperus communis* L.	2
Common mullein	*Verbascum thapsus* L.	9
Common reed	*Phragmites australis* (Cav.) Trin.	2
Common scouring-rush	*Equisetum hyemale* L.	4
Common silverweed	*Potentilla anserina* L.	1
Common snowberry	*Symphoricarpos albus* (L.) Blake	5
Common spikesedge	*Eleocharis palustris* (L.) R. & S.	2
Common wormwood	*Artemisia absinthium* L.	1
Common yarrow	*Achillea millefolium* L.	10
Creeping juniper	*Juniperus horizontalis* Moench	3
Crested wheatgrass	*Agropyron cristatum* (L.) Gaertn.	25
Curlycup gumweed	*Grindelia squarrosa* (Pursh) Dunal	11
Currant; gooseberry	*Ribes* spp. L.	1

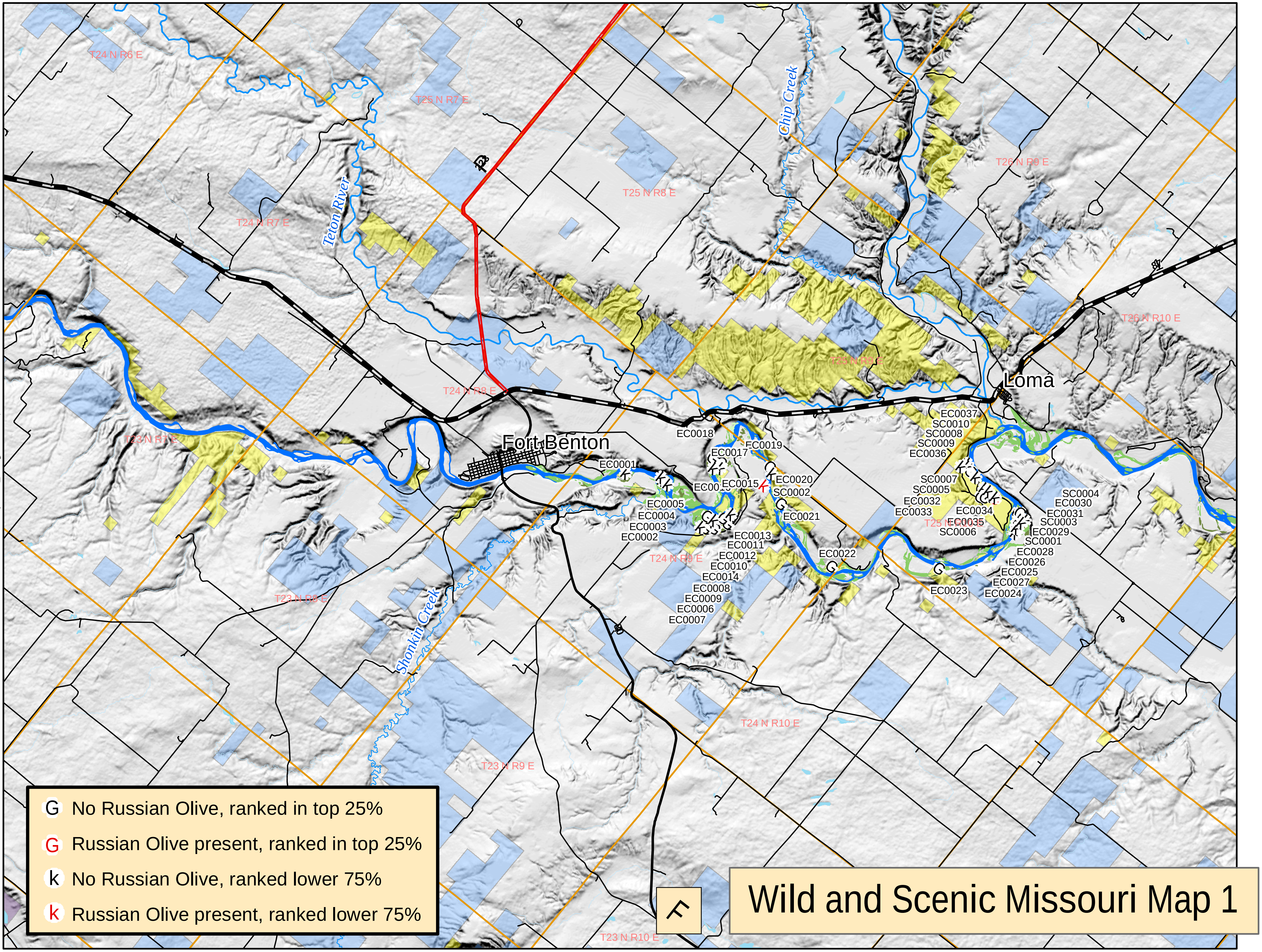
Table 7. Continued

Common name	**Scientific Name**	**Occurences in 154 plots**
Diamond willow	*Salix eriocephala* Michx.	7
Diamond willow	*Salix rigida* Muhl.	1
Diffuse knapweed	*Centaurea diffusa* Lam.	3
Dock; sorrel	*Rumex* spp. L.	1
Dodder	*Cuscuta* spp. L.	1
Field horsetail	*Equisetum arvense* L.	4
Field mint	*Mentha arvensis* L.	1
Field morning-glory	*Convolvulus arvensis* L.	1
Four-wing saltbush	*Atriplex canescens* (Pursh) Nutt.	4
Foxtail barley	*Hordeum jubatum* L.	3
Fringed sagewort	*Artemisia frigida* Willd.	1
Goat's beard	*Tragopogon dubius* Scop.	13
Golden currant	*Ribes aureum* Pursh	32
Goosefoot	*Chenopodium* spp. L.	1
Great plains cottonwood	*Populus deltoides* Marsh.	143
Green ash	*Fraxinus pennsylvanica* Marsh.	27
Green milkweed	*Asclepias viridiflora* Raf.	6
Green needlegrass	*Nassella viridula* (Trin.) Barkworth	50
Green rabbitbrush	*Chrysothamnus viscidiflorus* (Hook.) Nutt.	15
Hemp dogbane	*Apocynum cannabinum* L.	27
Horseweed	*Conyza canadensis* (L.) Cronq.	1
Inflated sedge	*Carex vesicaria* L.	3
Intermediate wheatgrass	*Agropyron intermedium* (Host) Beauv.	11
Japanese brome	*Bromus japonicus* Thunb.	30
Kentucky bluegrass	*Poa pratensis* L.	82
Lambsquarter	*Chenopodium album* L.	2
Lanceleaf cottonwood	*Populus xacuminata* Rydb.	17
Late goldenrod	*Solidago gigantea* Ait.	18
Leafy spurge	*Euphorbia esula* L.	78
Lenspod whitetop	*Cardaria chalapensis* (L.) Hand.-Maz.	1
Loeselii tumblemustard	Sisymbrium loeselii L.	5
Meadow foxtail	*Alopecurus pratensis* L.	1
Meadowrue	*Thalictrum* spp. L.	4
Milkweed	*Asclepias* spp. L.	7
Missouri goldenrod	*Solidago missouriensis* Nutt.	46
Missouri gooseberry	*Ribes setosum* Lindl.	58
Nettle-leaved giant hyssop	*Agastache urticifolia* (Benth.) Kuntze	8
Nightshade	*Solanum* spp. L.	1
Peach-leaf willow	*Salix amygdaloides* Anderss.	62
Pepperweed	*Lepidium* spp. L.	6
Plains prickly-pear	*Opuntia polyacantha* Haw.	7
Plum; cherry	*Prunus* spp. L.	1
Poison hemlock	*Conium maculatum* L.	5
Poison ivy	*Toxicodendron rydbergii* (Small ex Rydb.) Greene	30
Prairie coneflower	*Ratibida columnifera* (Nutt.) Woot. & Standl.	2
Prairie sagewort	*Artemisia ludoviciana* Nutt.	27
Prairie sandreed	*Calamovilfa longifolia* (Hook.) Scribn.	13
Prickly lettuce	*Lactuca serriola* L.	4

Table 7. Continued

Common name	Scientific Name	Occurences in 154 plots
Prickly rose	*Rosa acicularis* Lindl.	9
Quackgrass	*Agropyron repens* (L.) Beauv.	67
Rabbitfoot polypogon	*Polypogon monspeliensis* (L.) Desf.	1
Red-osier dogwood	*Cornus sericea* L.	21
Redtop	*Agrostis stolonifera* L.	8
Reed canarygrass	*Phalaris arundinacea* L.	5
Ricegrass	*Oryzopsis* spp. Michx.	2
Rocky Mountain juniper	*Juniperus scopulorum* Sarg.	24
Rough bugleweed	*Lycopus asper* Greene	1
Round-leaved thermopsis	*Thermopsis rhombifolia* Nutt.	3
Russian olive	*Elaeagnus angustifolia* L.	15
Ryebrome	*Bromus secalinus* L.	2
Saltbush; orache; shadscale	*Atriplex* spp. L.	4
Saltmarsh bulrush	*Scirpus maritimus* L.	1
Sandbar willow	*Salix exigua* Nutt.	10
Sedge	*Carex* spp. L.	3
Showy milkweed	*Asclepias speciosa* Torr.	40
Silver sagebrush	*Artemisia cana* Pursh	76
Skunk-bush sumac	*Rhus trilobata* Nutt.	38
Smooth brome	*Bromus inermis* Leys.	106
Smooth scouring-rush	*Equisetum laevigatum* A. Br.	12
Sneezeweed	*Helenium autumnale* L.	2
Spotted knapweed	*Centaurea maculosa* Lam.	34
Squaw currant	*Ribes cereum* Dougl.	2
Starry solomon-plume	*Smilacina stellata* (L.) Desf.	11
Stickseed	*Hackelia* spp. Opiz	1
Stinging nettle	*Urtica dioica* L.	3
Tarragon	*Artemisia dracunculus* L.	1
Thorny buffaloberry	*Shepherdia argentea* (Pursh) Nutt.	10
Thymeleaf speedwell	*Veronica serpyllifolia* L.	1
Torrey's rush	*Juncus torreyi* Cov.	1
Tumblemustard	*Sisymbrium altissimum* L.	25
Watson willow	*Salix lutea* Nutt.	30
Western meadowrue	*Thalictrum occidentale* Gray	2
Western serviceberry	*Amelanchier alnifolia* Nutt.	1
Western snowberry	*Symphoricarpos occidentalis* Hook.	107
Western virgins-bower	*Clematis ligusticifolia* Nutt.	13
Western wheatgrass	*Agropyron smithii* Rydb.	1
Western wheatgrass	*Pascopyrum smithii* (Rydb.) A. Love	48
Wheatgrass	*Agropyron* spp. Gaertn.	1
White clover	*Trifolium repens* L.	3
White sweet-clover	*Melilotus albus* Medik.	58
White-prairie aster	*Aster falcatus* Lindl.	2
Wildrye	*Elymus* spp. L.	4
Willow	*Salix* spp. L.	1
Woods rose	*Rosa woodsii* Lindl.	85
Yellow sweet-clover	*Melilotus officinalis* (L.) Pall.	10

APPENDIX D. MAPS


Wild and Scenic Missouri Map 1
G No Russian Olive, ranked in top 25%
G Russian Olive present, ranked in top 25%
k No Russian Olive, ranked lower 75%
k Russian Olive present, ranked lower 75%
Fort Benton
Loma
Teton River
Chip Creek
Shonkin Creek
T24 N R6 E
T25 N R7 E
T25 N R8 E
T24 N R7 E
T26 N R9 E
T26 N R10 E
T24 N R8 E
T23 N R7 E
T24 N R9 E
T23 N R8 E
T24 N R10 E
T23 N R9 E
T23 N R10 E
EC0001
EC0002
EC0003
EC0004
EC0005
EC0006
EC0007
EC0008
EC0009
EC0010
EC0011
EC0012
EC0013
EC0014
EC0015
EC0017
EC0018
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EC0022
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EC0029
EC0031
EC0032
EC0033
EC0034
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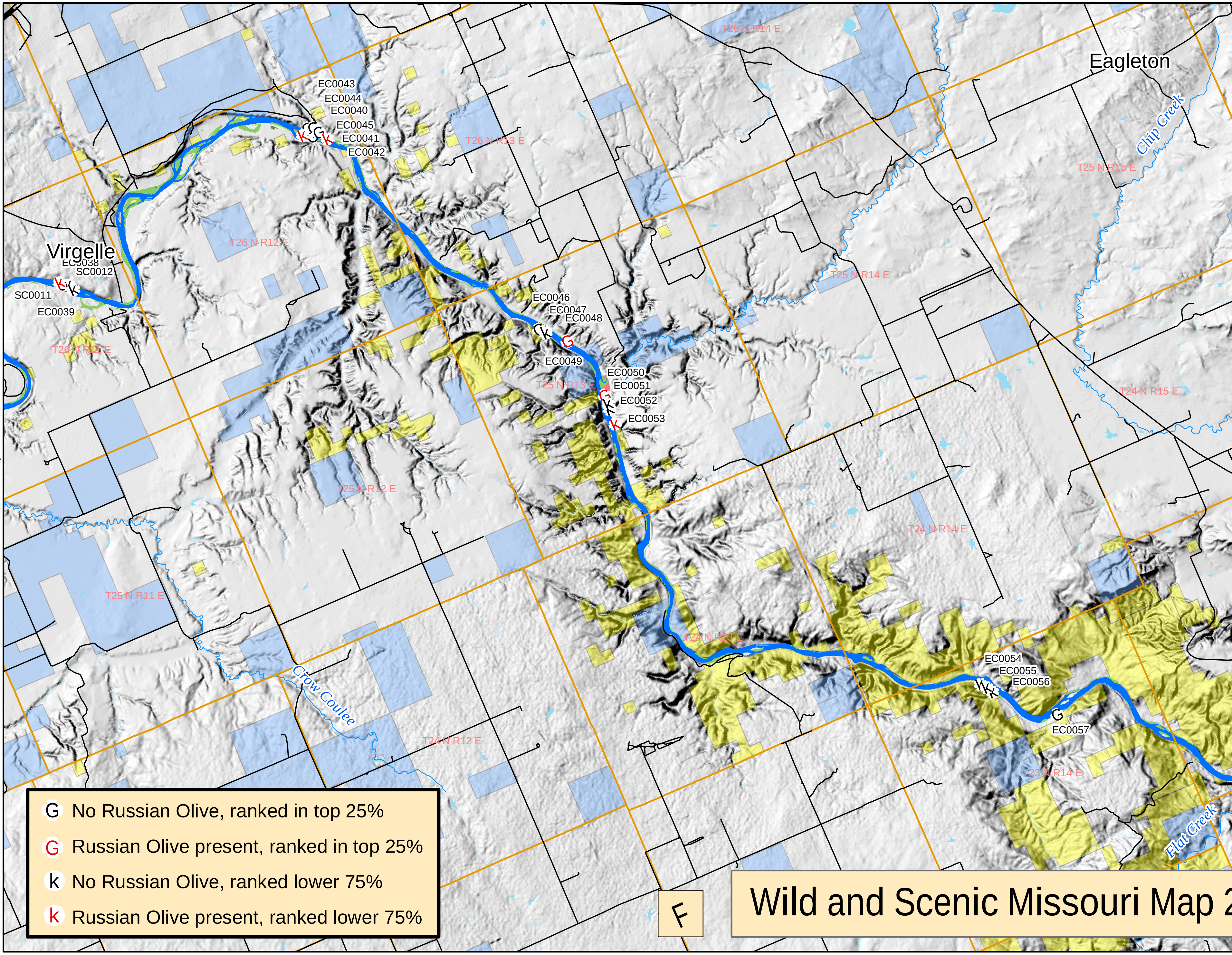
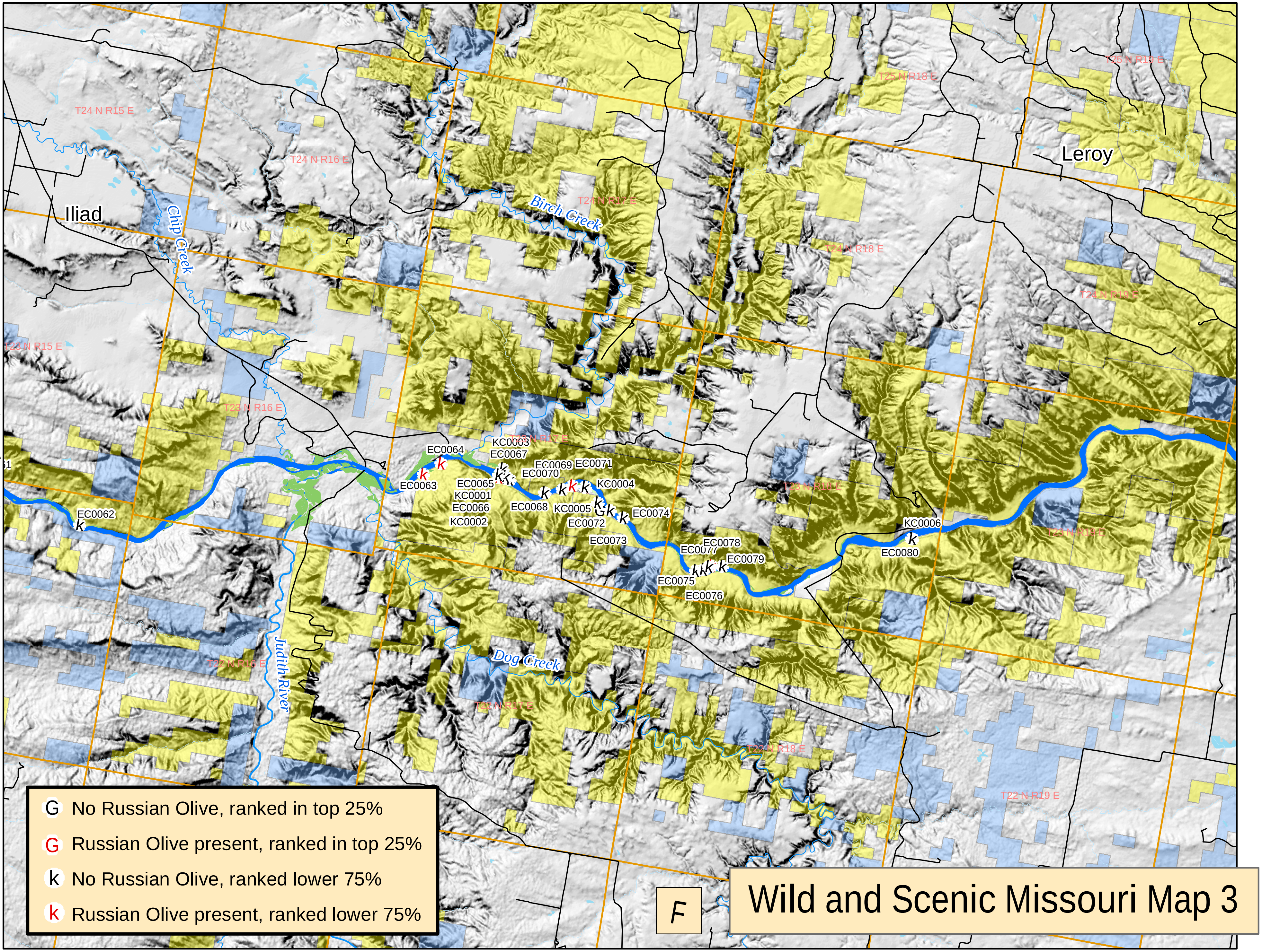
EC0037
SC0001
SC0002
SC0003
SC0004
SC0005
SC0006
SC0007
SC0008
SC0009
SC0010

Appendix D - 2



Wild and Scenic Missouri Map 2


Wild and Scenic Missouri Map 3
F
G No Russian Olive, ranked in top 25%
G Russian Olive present, ranked in top 25%
k No Russian Olive, ranked lower 75%
k Russian Olive present, ranked lower 75%
Iliad
Leroy
Chip Creek
Birch Creek
Dog Creek
Judith River
T24 N R15 E
T24 N R16 E
T24 N R17 E
T24 N R18 E
T24 N R19 E
T25 N R18 E
T25 N R19 E
T23 N R15 E
T23 N R16 E
T23 N R17 E
T23 N R18 E
T23 N R19 E
T22 N R16 E
T22 N R17 E
T22 N R18 E
T22 N R19 E
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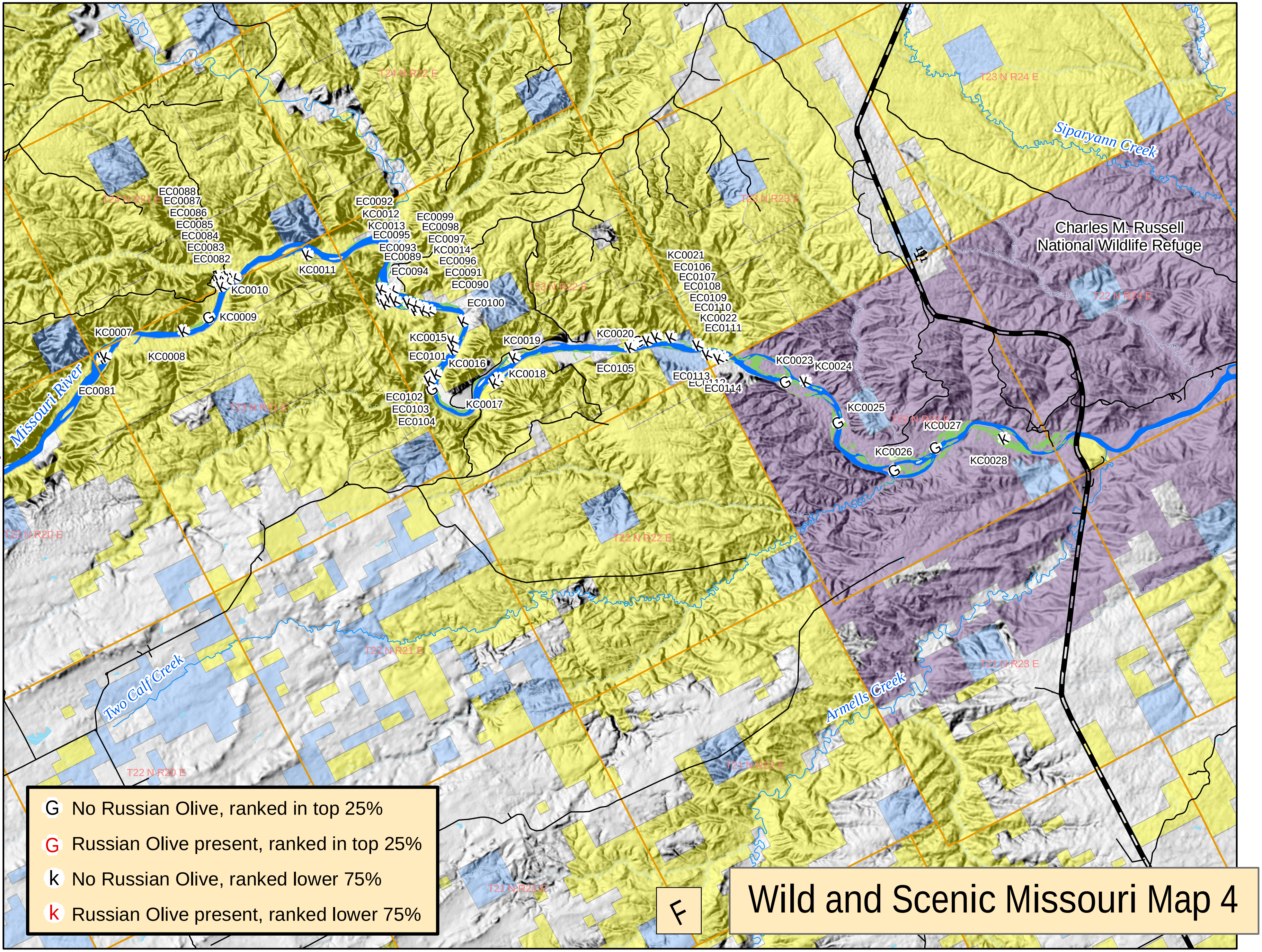
EC0079
KC0006
EC0080


Wild and Scenic Missouri Map 4
G No Russian Olive, ranked in top 25%
G Russian Olive present, ranked in top 25%
k No Russian Olive, ranked lower 75%
k Russian Olive present, ranked lower 75%
Charles M. Russell
National Wildlife Refuge
Missouri River
Siparyann Creek
Two Calf Creek
Armells Creek
191
T24 N R22 E
T24 N R21 E
T23 N R24 E
T23 N R23 E
T23 N R22 E
T23 N R21 E
T23 N R20 E
T22 N R24 E
T22 N R22 E
T22 N R21 E
T22 N R20 E
T21 N R23 E
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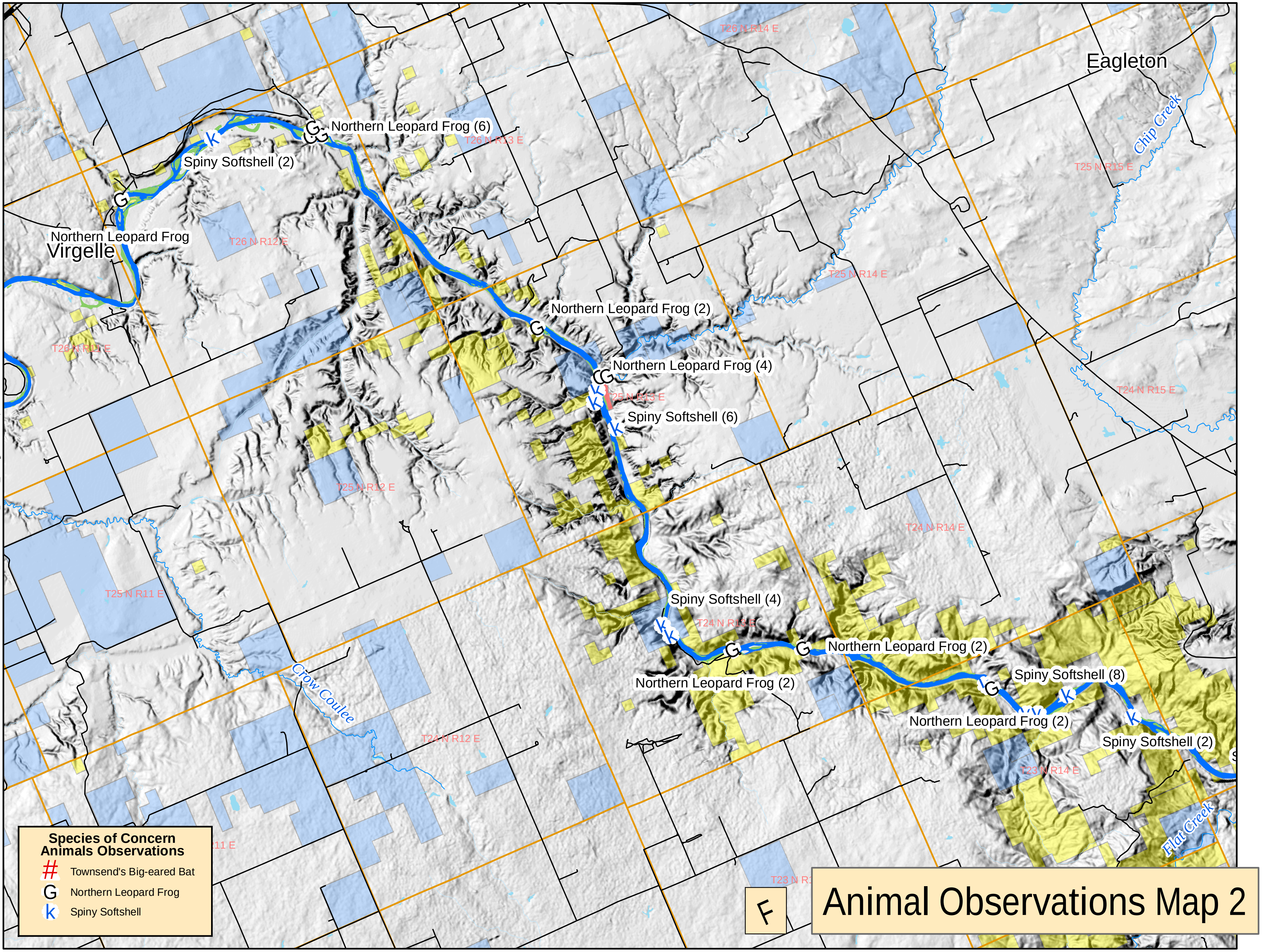
KC0026
KC0027
KC0028
F



Animal Observations Map 2
F
Species of Concern Animals Observations
Townsend's Big-eared Bat
Northern Leopard Frog
Spiny Softshell
Eagleton
Virgelle
Chip Creek
Crow Coulee
Flat Creek
Northern Leopard Frog (6)
Spiny Softshell (2)
Northern Leopard Frog
Northern Leopard Frog (2)
Northern Leopard Frog (4)
Spiny Softshell (6)
Spiny Softshell (4)
Northern Leopard Frog (2)
Northern Leopard Frog (2)
Spiny Softshell (8)
Northern Leopard Frog (2)
Spiny Softshell (2)
T26 N R14 E
T26 N R13 E
T26 N R12 E
T26 N R11 E
T25 N R15 E
T25 N R14 E
T25 N R13 E
T25 N R12 E
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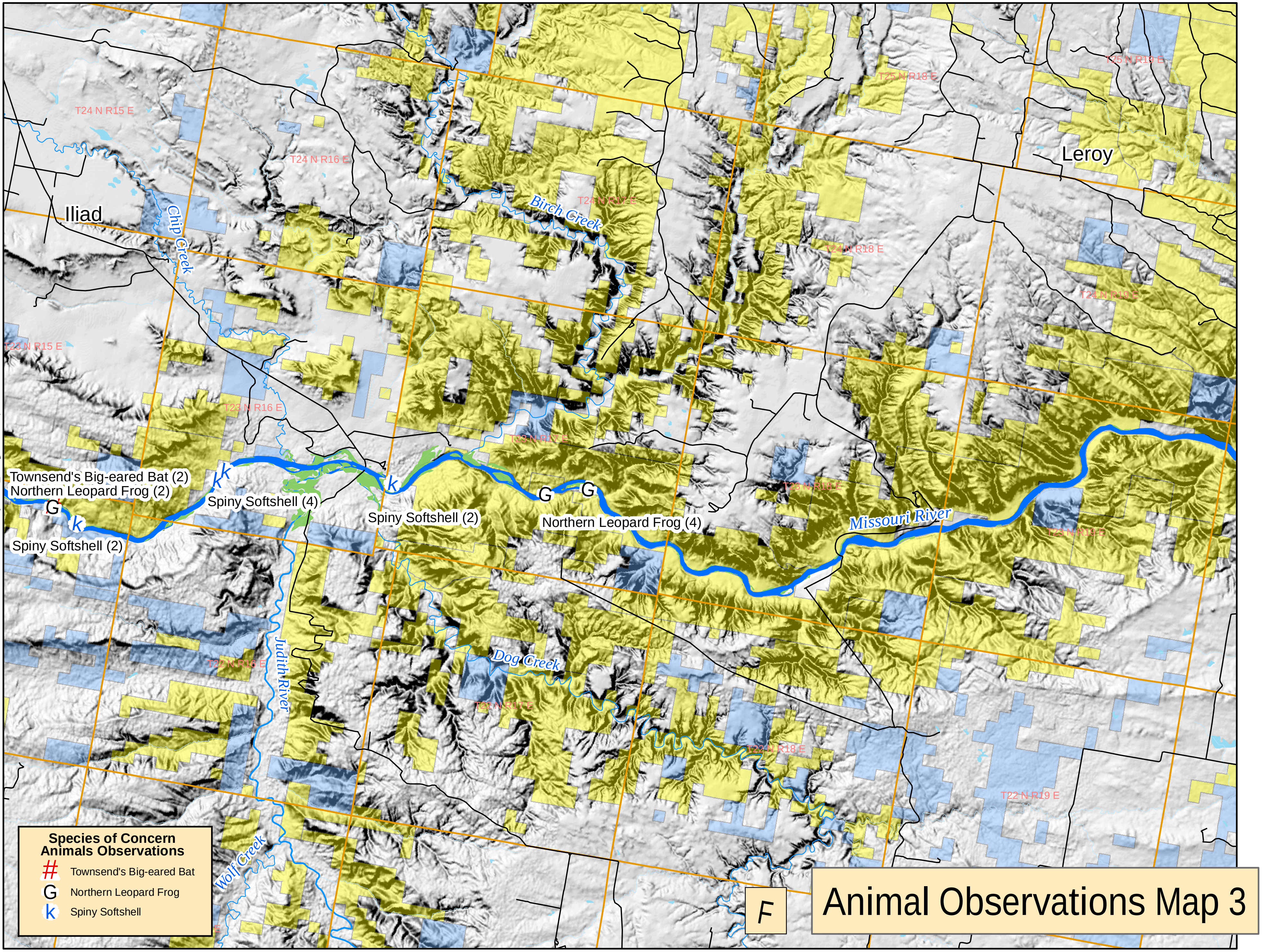
T24 N R15 E
T24 N R14 E
T24 N R13 E
T24 N R12 E
T23 N R14 E

Appendix D - 6



Animal Observations Map 3
F
Species of Concern
Animals Observations
Townsend's Big-eared Bat
Northern Leopard Frog
Spiny Softshell
Iliad
Leroy
Chip Creek
Birch Creek
Missouri River
Judith River
Dog Creek
Wolf Creek
Townsend's Big-eared Bat (2)
Northern Leopard Frog (2)
Spiny Softshell (2)
Spiny Softshell (4)
Spiny Softshell (2)
Northern Leopard Frog (4)
T24 N R15 E
T24 N R16 E
T24 N R17 E
T24 N R18 E
T24 N R19 E
T25 N R18 E
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